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Research Article

Perceived quality of vaccination services and complete vaccination among children aged 12–23 months in Tshopo, Democratic Republic of the Congo

Running title: Perceived quality of vaccination services and complete vaccination, Tshopo, DRC

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Abstract

Background: Complete childhood vaccination coverage remains low in the Democratic Republic of the Congo (DRC). We assessed the association between mothers'/caregivers' perceptions of vaccination service quality and complete vaccination among children aged 12–23 months in Tshopo Province, and identified the dimensions of perceived quality involved.

Methods: We conducted a secondary analysis of cross-sectional data from the 2023 Vaccination Coverage Survey (data collected in April–May 2024), including 1,903 mothers/caregivers of children aged 12–23 months. Seven dimensions of perceived service quality and a composite perception score were examined; the score showed moderate internal consistency (Cronbach's alpha = 0.62). Weighted bivariate and multivariable logistic regression models, adjusted for maternal sociodemographic factors, were used to estimate crude and adjusted odds ratios (AOR) with 95% confidence intervals (CI).

Results: Weighted complete vaccination coverage was 17.9%. After adjustment, complete vaccination was associated with maternal satisfaction with services (AOR 6.20; 95% CI 3.11–12.35), perceived easy geographic access (AOR 2.64; 95% CI 1.09–6.37), urban residence (AOR 2.33; 95% CI 1.62–3.33), and high household wealth (AOR 1.45; 95% CI 1.03–2.03). Affordability, conformity with religious beliefs, and follow-up by health personnel or community health workers were not independently associated. A favorable overall perception was associated with complete vaccination in crude analysis (OR 6.10; 95% CI 3.72–9.99).

Conclusions: Maternal satisfaction and perceived geographic accessibility were associated with complete vaccination in Tshopo. Person-centred services and improved access in rural areas deserve priority. The cross-sectional design precludes causal inference.

Keywords: vaccination coverage; perceived service quality; maternal satisfaction; mothers/caregivers; Tshopo; Democratic Republic of the Congo.

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I. **Introduction**

Vaccination is one of the most significant achievements of global health and development [1]. According to the World Health Organization (WHO), vaccines now protect against more than 20 potentially fatal diseases, including measles, tetanus, influenza, diphtheria, and pertussis, and prevent an estimated 3.5 to 5 million deaths each year [1,2].

As a cornerstone of public health, immunization contributes to 14 of the 17 Sustainable Development Goals (SDGs) by strengthening global health security and reducing the morbidity and mortality associated with vaccine-preventable diseases [1]. It is also one of the most cost-effective public health investments, with an estimated return of US$52 for every dollar invested in immunization programs in 94 low- and middle-income countries between 2011 and 2030 [3].

Despite being a key component of primary health care and a human right, access to vaccines remains a major challenge, particularly in low-income countries. In 2024, nearly 20 million infants worldwide missed at least one dose of a diphtheria-tetanus-pertussis (DTP)-containing vaccine, including 14.3 million "zero-dose" children who had not received any vaccine [4,5]. More than half of these zero-dose children live in nine countries, including the DRC, Nigeria, and Ethiopia [4]. The COVID-19 pandemic seriously disrupted routine immunization services and aggravated this situation [6]. In the WHO African Region, the number of zero-dose children rose to 7.7 million in 2022, with Nigeria, Ethiopia, and the DRC among the ten countries with the highest numbers [7].

The Immunization Agenda 2030 identifies a "people-centered" approach as one of its guiding principles: it is no longer sufficient for services to be available and accessible; they must also be of sufficient quality to meet the needs of the populations they serve and to build trust, so as to sustain demand and maintain equitable coverage [1].

Perceived quality reflects a user's judgment and corresponds to the gap between the service expected and the service actually received [8,9]. In vaccination services, it depends on factors such as reception by staff, vaccine availability, and the perceived competence of providers [10–12]. In India, Titoria et al. concluded that improving vaccination coverage requires identifying and addressing gaps in the quality of routine immunization services as perceived by clients, and found that provider behavior and facility infrastructure influenced overall beneficiary satisfaction [10].

The literature also indicates that a welcoming environment, the consistent availability of vaccines and supplies, positive provider attitudes, the delivery of the desired services, and follow-up by providers and community health workers are quality dimensions that enhance maternal satisfaction, encourage continued use of services, and improve vaccination coverage among target children [10–17]. Other dimensions studied include waiting time, accessibility, and respect for clients. Conversely, negative experiences related to poor service quality can reduce service use and leave children vulnerable to disease [11,18].

The DRC faces major challenges in achieving complete vaccination. According to the 2023 Vaccination Coverage Survey (VCS) report, complete vaccination coverage among children aged 12–23 months was 38.3%, compared with 45.3% in 2022 and 52.5% in 2020 [19]. Despite initiatives such as the 2019 Emergency Plan to Strengthen the Expanded Program on Immunization (MASHAKO Plan), the country remains among those with the highest numbers of zero-dose and under-vaccinated children [4,20].

Tshopo is one of the DRC provinces with the lowest complete vaccination coverage, estimated at 17.7% in the 2023 VCS, compared with 8.5% in 2022 and 24.8% in 2020 [19]. The province is also frequently exposed to outbreaks of vaccine-preventable diseases such as measles and poliomyelitis, and to high child mortality: according to the 2017–2018 Multiple Indicator Cluster Survey combined with malaria (MICS-Palu), 60 of 1,000 children in Tshopo died before their fifth birthday. This is lower than the national figure of 70 per 1,000 but remains far from the SDG 3.2 target of at most 25 deaths per 1,000 live births [21–23].

To our knowledge, no study in Tshopo has explored mothers' and caregivers' perceptions of

the quality of routine immunization services or how these perceptions are related to complete vaccination in children. We hypothesized that a more favorable perception of service quality is associated with higher odds of complete vaccination. The objective of this study was therefore to assess the association between mothers'/caregivers' perceptions of vaccination service quality and complete vaccination among children aged 12–23 months in Tshopo, and to identify the dimensions of perceived quality associated with it.

II. Materials and methods

2.1. Study setting

Tshopo Province is located in the north-east of the DRC. With an area of 199,567 km², it is the country's largest province and one of the four provinces created from the division of the former Orientale Province in 2015. Its health system comprises 23 health zones, subdivided into 432 health areas, and the population was estimated at 4,172,813 inhabitants in 2024. Malaria is the leading cause of death, and the province also faces epidemics of measles and mpox and the resurgence of circulating vaccine-derived poliovirus (cVDPV) cases [24].

2.2. Study design and data source

We performed a secondary analysis of cross-sectional data from the 2023 VCS, a household survey that is nationally representative and representative at the level of each of the country's 26 provinces [19]. The present analysis used only the data from Tshopo Province, collected between April and May 2024 in all 23 health zones. The study is reported according to the STROBE statement for cross-sectional studies [25].

2.3. Sampling and study population

The 2023 VCS targeted children aged 6 to 23 months. In Tshopo, all 23 health zones were included. A multistage cluster sampling design was used: five health areas were randomly selected in each health zone (first stage); 30% of the avenues/villages of each selected health area were randomly selected using the 6/16 segmentation (second stage); and 30 households with at least one child aged 6–23 months were selected by systematic random sampling in the selected avenues/villages (third stage) [26]. The survey included 3,450 households, 3,415 mothers/caregivers, and 3,458 children aged 6–23 months. The present analysis was restricted to the 1,903 mothers/caregivers of children aged 12–23 months (1,924 children).

2.4. Variables

Outcome. The outcome was complete vaccination of children aged 12–23 months. A child was considered fully vaccinated if he or she had received one dose of BCG, four doses of oral poliovirus vaccine (including the birth dose), three doses of pentavalent vaccine, three doses of 13-valent pneumococcal conjugate vaccine (PCV-13), one dose of inactivated poliovirus vaccine (IPV), one dose of measles vaccine, and one dose of yellow fever vaccine. Vaccination status was ascertained through document review (vaccination cards and registers) and observation (e.g., the BCG scar), as described in the survey protocol.

Perceived quality of vaccination services. Seven dimensions were considered, each dichotomized. Perceived geographic accessibility was assessed by asking how easy it was to reach the vaccination site ("difficult" vs "easy"). Perceived financial accessibility (affordability) covered direct non-medical costs (e.g., transport) and opportunity costs (e.g., lost work) ("unaffordable" vs "affordable"). Service reliability was measured by whether the child received the intended vaccine at the last visit ("yes" vs "no"). Perceived conformity with religious beliefs was assessed by the extent to which vaccination aligned with the mother's/caregiver's beliefs ("low conformity/uncertain" vs "high conformity"). Follow-up by health personnel and follow-up by community health workers were two separate items ("yes" vs "no"). Finally, maternal satisfaction with the vaccination services was coded "satisfied" vs "not satisfied".

To summarize these dimensions, a composite perception score was calculated as the mean of the seven binary items, each coded 1 (positive perception) or 0 (neutral/negative). Internal consistency was moderate (Cronbach's $\alpha = 0.62$) [27]. For regression analysis, the score was dichotomized at 0.5 (i.e., at least four of seven positive items): scores below 0.5 defined an "unfavorable overall perception" and scores of 0.5 or above a "favorable overall perception".

Covariates. Maternal sociodemographic factors were included as potential confounders because previous studies have shown their association with childhood vaccination [20,28–33]: maternal age (15–24 vs ≥25 years), marital status (living alone vs in union), education (less than secondary vs secondary or higher), occupation (employed vs unemployed), place of residence (rural vs urban), and household wealth. Wealth was derived from household assets following the Demographic and Health Surveys methodology [34], with quintiles grouped into "low to medium" (three lowest quintiles) and "high" (two highest quintiles).

2.5. Data collection and quality assurance

Data were collected through interviews with mothers/caregivers of children aged 12–23 months, eligible heads of households, and health workers, complemented by observation (e.g., the BCG scar) and document review (vaccination cards and records). Data were entered directly into an electronic form using the Open Data Kit (ODK) application and transmitted to a secure server. Interviewers were selected on the basis of their competence, prior experience in vaccination coverage and public health surveys, and success in selection tests. All interviewers received specific training, the data collection tool was pre-tested by interviewers and provincial supervisors, and each team had a field supervisor who checked data quality before submission to the server.

2.6. Statistical analysis

The database was cleaned and its completeness verified for the variables relevant to this study before analysis. Analyses were performed with Stata version 15 (StataCorp, College Station, TX, USA), applying the survey weighting variable; tables were prepared in Microsoft Excel. Categorical variables were summarized as absolute and relative frequencies. Crude odds ratios (OR) with 95% confidence intervals (CI) were estimated by bivariate logistic regression. Variables associated with complete vaccination at $p < 0.05$ in the bivariate analysis were entered simultaneously into a multivariable logistic regression model to estimate adjusted odds ratios (AOR) with 95% CI. Because the composite perception score is built from the individual dimensions, it was analyzed separately (crude OR) and was not entered in the same model as its components. All tests were two-sided with a significance level of 5%, and exact p-values are reported.

2.7. Ethical considerations

The 2023 VCS received all necessary approvals before data collection, including ethical clearance from the Ethics Committee of the Kinshasa School of Public Health (approval No. ESP/CE/025/2023) and authorizations from political and administrative authorities. Questionnaires were administered only to respondents who gave informed consent, and respondents could ask questions, refuse to answer, or stop the interview at any time. The present secondary analysis used anonymized data, and confidentiality was maintained throughout.

III. Results

3.1. Characteristics of the study population

The analysis included 1,903 mothers/caregivers of children aged 12–23 months. Weighted complete vaccination coverage was 17.9%. Table 1 presents the sociodemographic characteristics. Overall, 839 respondents (44.1%) were younger than 25 years, 1,740 (91.4%) were married or in union, 830 (43.6%) had not reached secondary education, 400 (21.0%) were unemployed, 1,492 (78.4%) lived in rural areas, and 1,221 (64.2%) belonged to the low-to-medium wealth group.

3.2. Perceived quality of vaccination services

Access to vaccination services was perceived as difficult by 464 respondents (24.4%), and 923 (48.5%) considered vaccination unaffordable. A large majority, 1,753 (92.1%), reported receiving the desired vaccine, meaning they were not turned away. Follow-up was infrequent: 1,442 respondents (75.8%) reported never having been contacted by health staff when their child was due for vaccination, and 1,292 (67.9%) reported no home visit by community health workers. Vaccination was perceived as highly consistent with religious beliefs by 875 respondents (46.0%), and 702 (36.9%) were not satisfied with the vaccination services. Overall, 739 respondents (38.8%) had an unfavorable perception of the services (Table 1).

Table 1. Sociodemographic characteristics and perceived quality of vaccination services among mothers/caregivers of children aged 12–23 months, Tshopo Province, DRC (N = 1,903).

Characteristic	n	%
Sociodemographic characteristics		
Age of mother/caregiver		
15–24 years	839	44.1
≥25 years	1064	55.9
Marital status		
Lives alone	163	8.6
Married/in union	1740	91.4
Level of education		
Less than secondary	830	43.6
Secondary or higher	1073	56.4
Occupational status		
Unemployed	400	21.0
Employed	1503	79.0
Place of residence		
Rural	1492	78.4
Urban	411	21.6
Household wealth		
Low to medium (quintiles 1–3)	1221	64.2
High (quintiles 4–5)	682	35.8
Perceived quality of vaccination services		
Geographic accessibility		
Difficult	464	24.4
Easy	1439	75.6
Affordability		
Unaffordable	923	48.5
Affordable	980	51.5
Receipt of the desired vaccine (reliability)		
No	150	7.9
Yes	1753	92.1
Conformity with religious beliefs		
Low conformity/uncertain	1028	54.0
High conformity	875	46.0
Follow-up by health personnel		
No	1442	75.8
Yes	461	24.2
Follow-up by community health workers		
No	1292	67.9
Yes	611	32.1
Maternal satisfaction		
Not satisfied	702	36.9
Satisfied	1201	63.1
Overall perception (composite score)		
Unfavorable	739	38.8
Favorable	1164	61.2

3.3. Factors associated with complete vaccination

Sociodemographic factors. In the bivariate analysis, complete vaccination was significantly associated with maternal age ≥25 years (OR 1.39; 95% CI 1.02–1.89; p = 0.04), secondary or higher education (OR 2.43; 95% CI 1.77–3.35; p < 0.001), urban residence (OR 3.21; 95% CI 2.36–4.37; p < 0.001), and high household wealth (OR 3.25; 95% CI 2.42–4.36; p < 0.001) (Table 2). In the multivariable model, urban residence (AOR 2.33; 95% CI 1.62–3.33; p < 0.001) and high household wealth (AOR 1.45; 95% CI 1.03–2.03; p = 0.03) remained significantly associated with complete vaccination, whereas maternal age (AOR 1.14; 95% CI 0.82–1.59; p = 0.45) and education (AOR 1.26; 95% CI 0.90–1.77; p = 0.17) did not.

Table 2. Factors associated with complete vaccination among children aged 12–23 months, Tshopo Province, DRC: bivariate and multivariable logistic regression.

Characteristic	Complete vaccination, %[a]	cOR (95% CI)[b]	p	aOR (95% CI)[c]	p
1. **Sociodemographic factors**					
Age of mother/caregiver					
15–24 years	15.3	1		1	
≥25 years	20.0	1.39 (1.02–1.89)	0.040	1.14 (0.82–1.59)	0.450
Mother's/caregiver's education					
Less than secondary	10.5	1		1	
Secondary or higher	22.2	2.43 (1.77–3.35)	<0.001	1.26 (0.90–1.77)	0.170
Place of residence					
Rural	11.6	1		1	
Urban	29.8	3.21 (2.36–4.37)	<0.001	2.33 (1.62–3.33)	<0.001
Household wealth					
Low to medium	10.3	1		1	
High	27.1	3.25 (2.42–4.36)	<0.001	1.45 (1.03–2.03)	0.030
2. **Perceived quality of vaccination services**					
Geographic accessibility					
Difficult	2.6	1		1	
Easy	22.5	10.95 (4.64–25.80)	<0.001	2.64 (1.09–6.37)	0.031
Affordability					
Unaffordable	10.0	1		1	
Affordable	24.7	2.96 (2.15–4.07)	<0.001	1.24 (0.88–1.75)	0.218
Conformity with religious beliefs					
Low or uncertain	14.5	1		1	
High	21.6	1.62 (1.19–2.22)	0.002	1.23 (0.87–1.72)	0.238
Follow-up by health personnel					
No	15.9	1		1	
Yes	24.4	1.70 (1.24–2.34)	0.001	1.23 (0.85–1.79)	0.274
Follow-up by community health workers					
No	15.8	1		1	
Yes	22.7	1.56 (1.15–2.12)	0.004	1.27 (0.89–1.83)	0.192
Maternal satisfaction with services					
Not satisfied	3.0	1		1	
Satisfied	26.2	11.63 (5.68–23.76)	<0.001	6.20 (3.11–12.35)	<0.001

cOR, crude odds ratio; aOR, adjusted odds ratio; CI, confidence interval; ECV, Vaccination Coverage Survey.

[a] Weighted percentage of children fully vaccinated within each category.

[b] Bivariate (unadjusted) logistic regression.

Dimensions of perceived quality. In the bivariate analysis, easy geographic access, affordability, conformity with religious beliefs, follow-up by health personnel, follow-up by community health workers, and maternal satisfaction were all positively associated with complete vaccination (Table 2). After adjustment, two dimensions remained significant. Children of mothers/caregivers who perceived access as easy had higher odds of being fully vaccinated (AOR 2.64; 95% CI 1.09–6.37; p = 0.031), and children of satisfied mothers/caregivers had six times higher odds than those of dissatisfied ones (AOR 6.20; 95% CI 3.11–12.35; p < 0.001). Affordability (AOR 1.24; 95% CI 0.88–1.75; p = 0.218), conformity with religious beliefs (AOR 1.23; 95% CI 0.87–1.72; p = 0.238), follow-up by health personnel (AOR 1.23; 95% CI 0.85–1.79; p = 0.274), and follow-up by community health workers (AOR 1.27; 95% CI 0.89–1.83; p = 0.192) were no longer significant.

Overall perception. A favorable overall perception of service quality was associated with markedly higher odds of complete vaccination in the crude analysis (OR 6.10; 95% CI 3.72–9.99; p < 0.001); complete vaccination coverage was 25.2% among mothers/caregivers with a favorable perception and 5.2% among those with an unfavorable perception (Table 2).

IV. Discussion

4.1. Key findings

In this secondary analysis of the 2023 VCS in Tshopo, weighted complete vaccination coverage among children aged 12–23 months was only 17.9%. Two dimensions of perceived service quality, geographic accessibility (AOR 2.64) and maternal satisfaction (AOR 6.20), were independently associated with complete vaccination, together with urban residence (AOR 2.33) and high household wealth (AOR 1.45). A favorable overall perception of service quality was associated with six-fold higher crude odds of complete vaccination. These results support our hypothesis that perceptions of service quality matter for vaccination outcomes, in line with studies linking community perceptions and satisfaction to vaccination uptake in Africa [35,36]. Because of the cross-sectional design, they must be interpreted as associations rather than causal effects.

The coverage observed lies between the 24.8% recorded in 2020 and the 8.5% recorded in 2022 [19], which underlines the persistent difficulties of the province. Tshopo should therefore be a priority target for intensified national efforts to improve Expanded Program on Immunization (EPI) indicators and to reduce child mortality from vaccine-preventable diseases.

4.2. Sociodemographic factors

Children living in urban areas had 2.3 times higher odds of being fully vaccinated than those in rural areas, consistent with studies from several countries [28–30]. This urban advantage may reflect easier geographic access to services and a higher proportion of educated women in urban settings [20], both recognized determinants of vaccination uptake [29,30]. With 78.4% of our respondents living in rural areas, the rural–urban gap has a considerable impact on provincial coverage. Mothers from high-wealth households also had higher odds of having a fully vaccinated child, in line with findings in sub-Saharan Africa and Nigeria [30,31] and with the wealth-related inequalities documented in low- and middle-income countries [37]. Greater financial resources may help households absorb indirect costs such as transport, thereby lowering barriers to vaccination.

Maternal education and maternal age were associated with complete vaccination in the bivariate analysis but not after adjustment. Education is known to promote preventive health behaviors and to shape attitudes and beliefs favorable to health-seeking [38–40], and older mothers may be more experienced with child health services [31,32]. The loss of significance in our multivariable model may be partly explained by the strong correlation of education with residence and household wealth, but this interpretation cannot be tested with our data. Maternal employment, which has been associated with greater empowerment and better child health outcomes in sub-Saharan Africa [28,33,41], was not associated with complete vaccination in our data (OR 0.77; 95% CI 0.53–1.10; $p = 0.15$).

4.3. Perceived quality of vaccination services

Perceived easy geographic access was a strong predictor of complete vaccination. Only 2.6% of children whose mothers/caregivers perceived access as difficult were fully vaccinated, compared with 22.5% of those who perceived access as easy. This is consistent with evidence that proximity of health facilities, by reducing travel distance, improves vaccination coverage and client satisfaction [29,30,36,42]. In a vast province where most respondents live in rural areas, this finding supports reinforcing outreach, advanced, and mobile vaccination strategies in hard-to-reach areas. The wide confidence interval (1.09–6.37) reflects the small number of fully vaccinated children among those reporting difficult access and calls for cautious interpretation of the magnitude of the effect. Maternal satisfaction was the strongest correlate of complete vaccination (AOR 6.20). Satisfaction is widely used as a proxy indicator of the quality of vaccination services [11]. Because a complete schedule requires several visits, satisfied mothers may be more likely to return, whereas negative experiences at vaccination visits can discourage further attendance [18,35]. Reverse causality is also plausible: mothers whose children completed the schedule may rate services more favorably, and the cross-sectional design cannot separate these directions. Only 3.0% of children of dissatisfied mothers were fully vaccinated, which explains the wide confidence interval (3.11–12.35).

Affordability, follow-up by health personnel, follow-up by community health workers, and conformity with religious beliefs were associated with complete vaccination in the bivariate analysis but not after adjustment. Financial barriers have

been shown to compromise childhood vaccination, particularly among poorer households [30,37]; in our data, the effect of affordability may have been absorbed by household wealth and place of residence, with which it is probably correlated. The role of follow-up by health workers and community relays has been emphasized in other settings [13,14], and the low levels observed here (only 24.2% and 32.1% of respondents reported follow-up by health staff and community health workers, respectively) point to an unexploited opportunity even though these dimensions were not independently significant. Likewise, alignment of vaccination with religious beliefs, although not significant here, remains a relevant consideration for person-centered strategies [1,16]. The limited power of binary items and the possible correlation among perception items may have contributed to these non-significant adjusted associations.

4.4. Implications for practice and policy

Our findings suggest that improving complete vaccination in Tshopo requires acting simultaneously on access and on the quality of the user experience. Priorities could include (i) extending outreach and mobile strategies to rural and hard-to-reach health areas; (ii) strengthening provider–caregiver interaction, including reception, communication, and respect for clients; and (iii) systematically reinforcing reminder and follow-up systems through health staff and community health workers. Integrating routine measurement of caregiver satisfaction into supervision and monitoring of EPI services would be consistent with the people-centered principle of the Immunization Agenda 2030 [1].

4.5. Strengths and limitations

To our knowledge, this is the first study to examine these dimensions of perceived service quality in relation to complete vaccination in Tshopo. Its strengths include the use of a large, probabilistic, provincially representative sample covering all 23 health zones, standardized and pre-tested data collection tools with supervised data quality control, and weighted analyses adjusted for sociodemographic confounders.

Several limitations should be acknowledged. First, as a secondary analysis of cross-sectional data, the study can only indicate probable associations and cannot establish causality or temporality, and only variables collected by the survey were available, so residual confounding (for example, by distance in kilometers, security conditions, or health worker availability) cannot be excluded. Second, perceptions were measured with single binary items; this simplifies interpretation but loses information, and the composite score had only moderate internal consistency ($\alpha = 0.62$) and an arbitrary cut-off. Third, selection bias is unlikely to be substantial given random selection at each sampling stage, but non-response could not be assessed in the present analysis, and social desirability and recall bias in self-reported perceptions cannot be ruled out. Fourth, sparse reference categories produced wide confidence intervals for geographic access and satisfaction. Fifth, only variables significant at $p < 0.05$ in the bivariate analysis were entered in the multivariable model, which may have excluded some confounders. Finally, qualitative studies are needed to explore in depth how mothers and caregivers experience vaccination services and to gather their recommendations in order to design targeted strategies.

Conclusion

Tshopo has one of the lowest complete vaccination coverage rates among children aged 12–23 months in the DRC. In this study, the perceptions of mothers and caregivers were strongly associated with complete vaccination: perceived easy geographic access and maternal satisfaction emerged as the strongest independent correlates among the dimensions of service quality analyzed, along with urban residence and higher household wealth. These findings support person-centered strategies that improve both access to vaccination services, especially in rural and hard-to-reach areas, and the quality of the caregiver's experience. Longitudinal and qualitative studies are needed to confirm these associations and to guide context-adapted interventions.

Declarations

Conflict of interest: The authors declare that they have no conflict of interest.

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Authors' contributions: Conceptualization: J.B.N., M.B.F.W., E.M.M.; Methodology: J.B.N.,

M.B.F.W., E.M.M., A.L., O.C.; Formal analysis and interpretation: J.B.N., M.B.F.W., E.M.M., O.C. All authors reviewed and approved the manuscript.

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Ethical considerations

The 2023 VCS received all necessary approvals before data collection, including ethical clearance from the Ethics Committee of the Kinshasa School of Public Health (approval No. ESP/CE/025/2023) and authorizations from political and administrative authorities. Questionnaires were administered only to respondents who gave informed consent, and respondents could ask questions, refuse to answer, or stop the interview at any time. The present secondary analysis used anonymized data, and confidentiality was maintained throughout.

Declaration of AI-Assisted Tools

During the preparation of this manuscript, the authors used AI-assisted tools exclusively for language editing, grammar correction, and improving the clarity and readability of the text. These tools were not used to generate research data, perform statistical analyses, or formulate scientific conclusions. The authors critically reviewed and edited all AI-assisted content and take full responsibility for the accuracy, originality, and integrity of the final manuscript.

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