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Gender and equity barriers associated with complete childhood vaccination in six health districts of Cameroon: a mixed-methods study

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Abstract

Background

Despite the progress Cameroon's Expanded Programme on Immunization (EPI) has made, persistent inequalities in vaccination coverage reveal structural gender and equity barriers. This study aimed to identify and analyze these barriers in six priority health districts, to generate actionable evidence for strengthening equity in routine immunization services.

Methods

A mixed-methods study was implemented in March 2026 in six health districts representative of Cameroon's geographic, linguistic and security diversity: Belel (Adamaoua region), Mokolo (Far North), Touboro (North), Kumbo West and Wum (North-West), and Tiko (South-West). The quantitative component covered 1,451 households with at least one child aged 0–23 months, selected through multi-stage cluster sampling. A composite female-autonomy index and household wealth tertiles were constructed. Logistic regression models were fitted to identify determinants of complete vaccination, overall and by geographic zone (northern/southern districts). The qualitative component included 24 key-informant interviews with community and health-system actors and 12 focus group discussions with compliant and non-compliant parents, analyzed thematically using NVivo. Ethical approval was obtained from Cameroon's National Ethics Committee for Human Health Research (N°2026/04/1907/CE/CNERSH/SP/SPA).

Results

Overall complete age-appropriate vaccination coverage was 73.4%, ranging from 58.8% in Belel to 96.9% in Kumbo West. Mothers accompanied children to vaccination in 95.5% of cases, yet paternal permission was required in 26.8% of households (100% in Belel), and fathers alone controlled household finances for transport and care in 53.2% of cases. Inconvenient scheduling of vaccination sessions was the strongest supply-side predictor of incomplete vaccination (adjusted odds ratio [aOR] = 0.22; 95%CI 0.08–0.60; p = 0.003). Household wealth was the strongest overall predictor of complete vaccination (third versus first tertile: aOR = 2.22; 95%CI 1.32–3.72; p = 0.002). In southern districts, travel time exceeding 60 minutes reduced the odds of complete vaccination three-fold (aOR = 0.29; 95%CI 0.09–0.91; p = 0.033). Vaccine stock-outs were significantly associated with incomplete vaccination in northern districts (aOR = 0.42; 95%CI 0.18–0.98; p = 0.045). Place of birth was a robust predictor across all models (aOR = 2.36; 95%CI 1.68–3.30; p < 0.001). Positive-masculinity profiles (fathers financing transport, caring for other children, accompanying their spouse) were identified in every region as a mobilizable lever.

Conclusions

Rather than operating as an isolated obstacle, gender dynamics appear as a critical booster factor, amplifying and exacerbating existing systemic constraints. In fragile districts surveyed, incomplete vaccination and programmatic underperformance are primarily driven by hard structural, logistical, and institutional barriers. Sustainably improving coverage in the most disadvantaged districts requires the simultaneous engagement of men, strengthening of women's autonomy, support for community health workers, and correction of health-system deficiencies.

Background

Immunisation remains the most cost-effective public health intervention in terms of vaccine-preventable disease incidence and deaths, yet inequalities often linked to sex, geography and socio-economic status persist in who benefits from it [1–3]. Global initiatives such as the Immunisation Agenda 2030 (IA2030) emphasise that achieving universal vaccination coverage requires addressing the social barriers that limit access, including those linked to gender [4, 5]. Gender dynamics shape every stage of the pathway to vaccination, from household decision-making to service accessibility, requiring immunisation programmes to move beyond a purely biomedical model toward approaches that account for users' social realities [6].

In many low- and middle-income countries (LMICs), women are the main caregivers for children yet often have limited control over household finances, transportation and decision-making, which restricts their ability to bring children for vaccination [1, 3]. Structural barriers such as distance to health facilities, inconvenient service delivery hours, and the predominance of male healthcare providers can further limit women's attendance, particularly where gender norms restrict their mobility or interactions with men outside their family circle [7]. Conversely, low male involvement in decisions about child health can lead to a poor understanding of the importance of vaccination [2].

In Cameroon, persistent disparities in vaccination coverage mirror the aforementioned gender and equity issues. Vaccination rates are generally lower among children born to mothers in rural areas with low income and limited education [8]. Data from HPV and COVID-19 vaccination programmes indicate that misinformation, gendered perceptions of vaccine safety, and male control over health decisions can limit uptake, particularly among adolescent girls and young women [9]. Health-system constraints such as stock-outs, understaffing and limited outreach add to the time and financial burden of caregivers, who must travel long distances to reach service delivery points.

Despite growing recognition of the importance of gender in childhood immunisation, empirical evidence on how gender and equity barriers manifest at the health-district level in Cameroon remains limited, and district-level immunisation data are rarely disaggregated by sex or socio-economic indicators [9]. This study aimed to evaluate the gender- and equity-related barriers influencing access to and use of vaccination services in some fragile and vulnerable health districts in Cameroon [4, 5].

Specific objectives were to: (i) examine equity-related barriers (socio-economic status, education, geography, household vulnerability) influencing vaccination coverage and use; (ii) describe gender-related barriers (social norms, household decision-making, gender roles) affecting access and use of vaccination services; (iii) assess the effectiveness of approaches currently implemented to reduce access inequalities; and (iv) propose evidence-based, gender-responsive strategies and recommendations to reduce inequalities and improve access to and use of vaccination services.

Methods

Study design

This descriptive and analytical cross-sectional study followed a mixed-methods design, combining a quantitative household survey with qualitative in-depth interviews (IDIs) and focus group discussions (FGDs). The quantitative component estimated the frequency of gender- and equity-related barriers and their association with vaccination outcomes, while the qualitative component explored underlying social norms, decision-making dynamics and health-system constraints.

Study sites and period

We purposively selected six health districts (HDs): Belel (Adamawa region), Mokolo (Far North), Touboro (North), Kumbo West and Wum (North-West), and Tiko (South-West). The choice was made out of 49 HDs with the highest number of zero-dose children, during the situational analysis for Cameroon's submission to Gavi's Full Portfolio Planning (FPP). Selection accounted for contexts of vulnerability, including security-compromised areas (Kumbo West, Tiko, Wum), remote rural areas (Belel, Mokolo, Touboro), and the country's geographic and socio-cultural diversity, spanning the western highlands (Grass Fields), the Sahel, and the coastal area. The study was conducted from November 2025 to May 2026, with data collection in March 2026.

Study population and eligibility

For the quantitative component, participants were parents/caregivers of children aged 0–23 months. The qualitative component targeted community health workers (CHWs), vaccination staff, district officials, community leaders and representatives of vulnerable populations. We included parents/caregivers aged 21 years or older (and minors with parental consent) resident in the community for more than six months, health professionals and CHWs active for more than six months, and community leaders who have held this position for at least six months. We excluded persons who were unable to provide informed consent/assent, persons too unwell to be interviewed, and staff of non-operational facilities during data collection.

Sample size and sampling

The minimum sample size for the household survey was calculated using the standard single-population-proportion formula (Z = 1.96 for 95% confidence; p = 0.5; precision d = 0.05), yielding n = 384. A design effect of 3 was applied to account for cluster sampling, plus 10% for anticipated non-response, giving a target of approximately 1,267 respondents (212 per district). We used a multi-stage cluster sampling procedure: (1) purposive selection of six of the 22 priority HDs; (2) simple random selection of four health areas (HAs) per HD, stratified by vaccination performance (< 80%/≥80%); (3) random selection of communities within each selected HA, stratified by distance (< 5 km, 5–15 km, > 15 km from the vaccinating health facility) or by hosting special population groups (internally displaced persons, refugees, indigenous peoples, and foreigners). Fourteen households with at least one child aged 0–23 months were surveyed per community (56 per health area); where several eligible caregivers were present, one was randomly selected. For qualitative sampling, purposive sampling was used to select four key informants and organise 2 FGDs (one exclusively with mothers, one exclusively with fathers) per district, combining ‘Doers’ (parents/caregivers of children fully vaccinated for age) and ‘Non-doers’.

Data collection

We collected quantitative data using a semi-structured, pre-tested questionnaire, administered electronically via the KoboCollect platform, capturing the child's vaccination status (verified from the vaccination card/health record, or by caregiver recall where documentation was unavailable), respondent sociodemographic characteristics, gender-related information (decision-making autonomy, resource control, mobility constraints), equity-related information (wealth proxies, distance to facility, household vulnerability), and supply- and demand-side barriers and facilitators. Real-time logic and consistency checks, geolocation and time-stamping supported data quality, complemented by daily supervisory review and field spot checks. Qualitative data were collected through semi-structured IDI and FGD guides, audio-recorded with participant consent and supplemented by field notes, exploring gender norms, household decision-making, perceptions of vaccine safety, provider attitudes, service accessibility, and reasons for incomplete vaccination among non-doers. All tools were developed in English, translated into French using back-translation for consistency, and piloted for one day at non-study sites before data collection started. Data collectors and supervisors underwent two days of intensive training covering study objectives, sampling procedures, ethics and informed consent, and gender-sensitive interview techniques, including practical exercises with the electronic data collection tools. The questionnaire, IDI and FGD guides were developed for this study; they are available as supplementary file.

Data analysis

Quantitative data were curated in Microsoft Excel and analysed in Stata 16.0. Descriptive analysis summarised sociodemographic and economic characteristics, gender-related factors, service access and delivery dynamics, vaccination status, and vaccination-related knowledge and attitudes. Principal component analysis was used to derive a household wealth score from asset ownership and primary

water source, and wealth tertiles were constructed from this score (each representing 33.3% of the sample). A composite female-autonomy index was constructed from five dimensions (participation in vaccination decisions, independent decision-making in case of spousal disagreement, level of influence in child-health decisions, control of household health-related finances, and educational attainment) through Maximum-Likelihood Factor Analysis, after ordered numeric recoding (internal consistency $\alpha = 0.687$); the resulting factor score was normalized to a 0–100 scale and categorized as low (< 33), moderate (33–65) or high (≥ 66) autonomy. Bivariate analysis (chi-square or Fisher's exact test; variables with $p < 0.1$ retained) preceded multivariable logistic regression, fitted separately for the overall sample and for northern (Belel, Mokolo, Touboro) and southern (Kumbo West, Tiko, Wum) HD subsamples. Absence of multicollinearity was verified via variance inflation factors (VIF); Model Calibration was assessed with the Hosmer-Lemeshow goodness-of-fit test. Statistical significance was set at 5%. IDI and FGD recordings were transcribed, then analysed thematically in NVivo using both inductive and deductive coding. Illustrative Quotations were used to support interpretation of quantitative findings. Analysis followed the modified Penchansky and Thomas's theory of access [10], and the Parker gender analysis matrix [11, 12].

Reporting followed the STROBE guideline for cross-sectional studies and the COREQ guideline for qualitative research; completed checklists are available from the corresponding author upon request.

Ethical considerations

The study received ethical approval from Cameroon's National Ethics Committee for Human Health Research (N°2026/04/1907/CE/CNERSH/SP/SPA), administrative authorisation from the Ministry of Public Health (E32-324/L/MINSANTE/SG/DSF/PEV/SPA/SPSE/USE), and agreement from the heads of the participating HDs. Written informed consent was obtained from all participants; parental consent and participant assent were obtained for participants aged under 21. Participation was voluntary, with no penalty for refusal or withdrawal and no effect on access to health services. Confidentiality was protected through participant coding, encrypted and password-protected storage of electronic data, and secure storage of physical documents, with no personally identifying information included in any report or publication.

Results

Population characteristics

A total of 1,451 households were surveyed across the six health districts, exceeding the minimum target of 212 households per HD in every site (Belel n = 238, Mokolo n = 236, Touboro n = 283, Kumbo West n = 227, Wum n = 242, Tiko n = 225). Respondents were predominantly (72.2%) young mothers (aged 21–34 years) and married (79.7%). Surveyed children had a mean age of 10.8 months (SD 6.5) and were mostly

born in a health facility (69.6%); however, home-birth rates exceeded 57% in Belel and Touboro, contrasting with near-universal facility births in Kumbo West and Tiko (Table 1).

Table 1
Sociodemographic characteristics of surveyed households and children (N = 1,451).

Characteristic	Category	n (%), N = 1,451
Child age (months)	Mean [SD]	10.8 [6.5]
	0–11 months	818 (56.4)
	12–23 months	633 (43.6)
Child sex	Female	761 (52.4)
	Male	690 (47.6)
Place of birth	Health facility	1,010 (69.6)
	Home	437 (30.1)
	Other	4 (0.3)
Respondent–child relationship	Mother	1,357 (93.5)
	Father	49 (3.4)
	Grandmother/other relative	35 (2.4)
	Other	10 (0.7)
Respondent age*	21–34 years	1,046 (72.2)
	35–49 years	317 (21.9)
	15–20 years	67 (4.6)
	≥ 50 years	18 (1.2)
Marital status	Married	1,157 (79.7)
	Never married	158 (10.9)
	Cohabiting (union libre)	95 (6.6)
	Divorced	16 (1.1)
	Separated	15 (1.0)
	Widowed	10 (0.7)
Number of live births**	1	257 (17.7)
	2–3	669 (46.2)
	4–5	331 (22.8)
	≥ 6	192 (13.3)

*3 missing values **2 missing values

Characteristic	Category	n (%), N = 1,451
Tertile of wealth	1st tertile (Poorer)	623 (42.9)
	2nd tertile (medium)	329 (22.7)
	3rd tertile (richer)	499 (34.4)
Household vulnerability	No vulnerability	751 (51.8)
	Unstable income / Recent job loss	358 (24.7)
	Single-parent household	242 (16.7)
	Chronically ill	22 (1.5)
	Person with a disability	34 (2.3)
	At least 2 of these vulnerabilities	44 (3.0)
*3 missing values **2 missing values		

Vaccination status

Overall complete age-appropriate vaccination coverage was 73.4%. Kumbo West showed the highest performance (96.9%), in contrast to Belel (58.8%) and Touboro (60.1%), the two lowest-performing districts. Wum showed a notably higher proportion of unknown vaccination status (11.2%) than other HDs. No statistically significant difference was observed between the proportion of girls (51.6%) and boys (48.5%) among fully vaccinated children (p = 0.15); across all six HDs. (Table 2).

Table 2
Complete age-appropriate vaccination status by district (N = 1,451).

Zone	District	Fully vaccinated n (%)	Not fully vaccinated n (%)	Unknown n (%)	Total
Northern districts	Belel	140 (58.8)	95 (39.9)	3 (1.3)	238
	Mokolo	183 (77.5)	52 (22.0)	1 (0.4)	236
	Touboro	170 (60.1)	113 (39.9)	0 (0.0)	283
	Subtotal north	493 (65.1)	260 (34.3)	4 (0.5)	757
Southern districts	Kumbo West	220 (96.9)	3 (1.3)	4 (1.8)	227
	Tiko	186 (82.7)	32 (14.2)	7 (3.1)	225
	Wum	166 (68.6)	49 (20.3)	27 (11.2)	242
	Subtotal south	572 (82.4)	84 (11.8)	38 (5.5)	694
Overall		1,065 (73.4)	344 (23.7)	42 (2.9)	1,451

The most frequently reported reasons for non-vaccination or incomplete vaccination were lack of information (26.7%, more pronounced in northern districts), time constraints (22.1%), transportation difficulties (17.2%, especially in remote rural districts), fear of adverse events following immunization (AEFI) (14.0%, notably in Wum), and child illness at the scheduled appointment (14.0%). Cultural/religious reasons and spousal refusal were particularly prominent in Wum (30.6% and 18.4%, respectively). Health-system failures were also cited, including vaccine stock-outs (9.3% overall, reaching 30.8% in Mokolo and 20.4% in Wum).

Gender-related and equity-related barriers

Across the six HDs, mothers accompanied children to vaccination in 95.5% of cases, yet decision-making authority remained frequently constrained: household decisions on the child's healthcare were made jointly by both parents in 56.4% of cases, by the mother alone in 32.1%, and by the father alone in 9.5% (rising to 42.4% in Belel). In 26.8% of households overall, and 100% in Belel, mothers reported being unable to vaccinate their child without the father's permission. Fathers alone controlled household finances for transportation and care in 53.2% of households (98.3% in Belel, 65.7% in Touboro), while mothers alone controlled these resources in only 16.8% of households. One father in the Far North summarized this authority structure directly: *“In my household, the mother cannot go out without my consent”* (EN_FGD_MOK_M_070426). A health worker in the same district corroborated: *“It is [the father] who gives the mother permission to bring the child for vaccination”* (EN_EI_MOK_PV_M_040426).

Financial support for transportation was the most frequently cited form of paternal involvement, and its absence was directly linked to missed appointments: a health worker in Tiko reported that *“some [mothers] openly tell you that their husbands did not give them money to come”* (SW_TIK_KII_CBH_070426). Conversely, positive-masculinity profiles were identified in every region, including fathers systematically accompanying their spouse, caring for older children during her absence, or financing transportation. They were described by respondents as a mobilizable for promoting social and behavioural change, if currently minority behaviour.

Women's practical availability for vaccination sessions was constrained by competing demands/chores: seasonal agricultural work, water and firewood collection, and domestic responsibilities were repeatedly cited as reasons for missed or delayed appointments, particularly given that sessions are generally scheduled on fixed weekday morning hours. A CHW in Wum described this workload directly: *“Most of them, it's work overload … within the period that you are expecting them at the vaccination post, at the end of the day, you will not see them”* (NW_WUM_KI_CAS_M_050426).

Household poverty and distance to the vaccinating facility emerged as the two most consistently cited equity barriers across all six HDs. Poorer households substitute routine vaccination with campaign-based vaccination, perceived as less costly due to its geographic proximity and absence of transportation fare, at the expense of the completeness of vaccination schedules: *“If it is far off, those people don't have money … when there's a campaign, that's when they can profit”* (SW_TIK_KII_FM_070426). Three population groups were repeatedly identified as particularly exposed to access challenges: poor households, displaced and nomadic populations, and geographically isolated communities. In the North-West, the security context added a further layer of inaccessibility, with health workers themselves describing certain communities as unreachable due to conflict-related risks.

Vaccine stock-outs, cold-chain deficiencies (including homologated cold chain equipment and unreliable electricity supply), understaffing, and the largely unremunerated status of CHWs were widely reported as structural weaknesses undermining continuity of service. Despite being unanimously described as central to community mobilization, CHWs conducted defaulter tracing and catch-up vaccination on a voluntary basis: *“It's a voluntary job, there is no motivation”* (EN_EI_MOK_GDS_M_070426); a community leader in Tiko added that health staff “believe that the CHWs are intruders. They are not partners” (SW_TIK_KII_CL_040426).

Community leader endorsement of vaccination was reported by 75.0% of respondents overall but ranged from 100% in Touboro and 94.1% in Belel to 45.8% in Tiko and 50.0% in Wum. Social sanctions linked to vaccination status were almost never reported (0.6%), and informal payments were reported by 3.2% of respondents overall (10.6% in Kumbo West). Confidence in vaccine safety was high, as 96.6% believed vaccines were safe for children, and 78.0% considered completing the vaccination schedule “very important”; however, 14.7% overall (35.0% in Touboro, 29.5% in Belel) did not know at which ages vaccines were most important. Exposure to vaccination messaging in the preceding six months was

reported by 96.9% of respondents, mainly via CHWs (80.6%) and health staff (61.8%), with markedly lower reach through digital media (6.7%) and radio/television (4.6%).

Determinants of complete vaccination: multivariable analysis

Multivariable logistic regression was performed on the overall sample and, separately, on the northern (Belel, Mokolo, Touboro) and southern (Kumbo West, Tiko, Wum) district subsamples, retaining variables significant at $p < 0.1$ in bivariate analysis and free of multicollinearity (variance inflation factor, VIF).

In the overall sample (mean VIF = 1.85; Hosmer-Lemeshow $p = 0.9778$), 10 variables were significantly associated with complete vaccination at the 5% level of significance (Table 3).

Table 3
Factors significantly associated with complete age-appropriate vaccination, overall sample (N = 1,451).

Variable (reference category)	Category	aOR	95% CI	p-value
Child age (0–11 months)	12–23 months	0.56	0.42–0.76	< 0.001
Place of birth (home)	Health facility	2.36	1.68–3.30	< 0.001
Marital status (married)	Cohabiting (union libre)	0.40	0.21–0.77	0.007
Wealth tertile (1st, poorest)	2nd tertile	1.50	1.00–2.24	0.046
Wealth tertile (1st, poorest)	3rd tertile (wealthiest)	2.22	1.32–3.72	0.002
Household vulnerability (none)	Unstable income	0.65	0.43–0.98	0.041
Usual transport mode (walking)	Motorbike/taxi	1.45	1.01–2.09	0.042
Session scheduling convenience (always)	Sometimes	0.68	0.49–0.96	0.029
Session scheduling convenience (always)	Rarely/never	0.22	0.08–0.60	0.003
Knows priority vaccination ages (all ages)	Doesn't know	0.36	0.14–0.91	0.032
Messages heard, last 6 months (1–2 times)	None	0.29	0.12–0.67	0.004
Messages heard, last 6 months (1–2 times)	3–5 times	1.89	1.32–2.69	< 0.001
Messages heard, last 6 months (1–2 times)	More than 5 times	1.89	1.17–3.07	0.009
Believes vaccines are safe (yes)	Uncertain/don't know	0.29	0.09–0.97	0.044
Believes vaccines are safe (yes)	No	0.04	0.00–0.35	0.004

aOR: adjusted odds ratio; CI: confidence interval. Mean VIF = 1.85; Hosmer-Lemeshow test p = 0.9778.

In the northern districts (mean VIF = 2.08; Hosmer-Lemeshow p = 0.2518), eight variables were significantly associated with complete vaccination, with vaccine stock-outs and perceived importance of completing the schedule among the strongest predictors (Table 4).

Table 4
Factors significantly associated with complete age-appropriate vaccination, northern districts (Belel, Mokolo, Touboro).

Variable (reference category)	Category	aOR	95% CI	p-value
Child age (0–11 months)	12–23 months	0.63	0.44–0.90	0.012
Place of birth (home)	Health facility	1.90	1.29–2.81	0.001
Vaccine found unavailable at a visit, last 12 months (no)	Yes	0.42	0.18–0.98	0.045
Session scheduling convenience (sometimes)	Always	1.69	1.02–2.78	0.041
Knows priority vaccination ages (0–1 year)	Doesn't know	0.49	0.25–0.97	0.041
Messages heard, last 6 months (1–2 times)	3–5 times	1.76	1.17–2.67	0.007
Messages heard, last 6 months (1–2 times)	More than 5 times	2.14	1.04–4.39	0.039
Importance of completing schedule (somewhat important)	Very important	3.86	2.49–5.98	< 0.001

aOR: adjusted odds ratio; CI: confidence interval. Mean VIF = 2.08; Hosmer-Lemeshow test p = 0.2518.

In the southern districts (mean VIF = 1.77; Hosmer-Lemeshow p = 0.3934), seven variables were significant (Table 5), with facility-level service disruptions (closure/staff absence) and lack of exposure to vaccination messaging showing the largest effect sizes.

Table 5
Factors significantly associated with complete age-appropriate vaccination, southern districts (Kumbo West, Tiko, Wum).

Variable (reference category)	Category	aOR	95% CI	p-value
Distance to vaccinating facility (5–15 km)	< 5 km	2.23	1.00–4.94	0.048
Community leaders encourage vaccination (uncertain)	Yes	3.08	1.33–7.16	0.009
Travel time to site (15–30 min)	More than 60 min	0.29	0.09–0.91	0.033
Facility closed/staff absent, last 12 months (no)	Yes	0.17	0.03–0.88	0.035
Session scheduling convenience (sometimes)	Rarely/never	0.28	0.08–0.98	0.046
Priority vaccination ages (0–1 year)	0–5 years	3.28	1.38–7.76	0.007
Messages heard, last 6 months (1–2 times)	None	0.12	0.04–0.34	< 0.001

aOR: adjusted odds ratio; CI: confidence interval. Mean VIF = 1.77; Hosmer-Lemeshow test p = 0.3934.

Synthesis using the gender analysis matrix and access framework

To structure the interpretation of gender-related findings across levels of analysis, results were organized within Parker's Gender Analysis Matrix [11, 12], which classifies findings across four levels of analysis (women, men, household, community) and four categories of analysis (labour, time, resources, culture) (Table 6). Two cells reflect a genuine gap in the underlying study material rather than an absence of relevance.

Table 6
Gender analysis matrix summarizing study findings by level and category of analysis, adapted from Parker's Gender Analysis Matrix [11, 12].

Level of analysis	Labour	Time	Resources	Culture
Women	Execute vaccination almost exclusively (95.5% of accompaniments); locally framed as primarily a maternal responsibility.	Availability curtailed by unpaid labour (seasonal farming, water/firewood collection, domestic chores), competing with fixed weekday-morning hours.	Control household transportation/care finances in only 16.8% of households overall (1.7% in Belel, 2.5% in Touboro).	Vaccination is subject to male authorization in 26.8% of households overall (100% in Belel); illustrated by a father's statement that "the mother cannot go out without my consent."
Men	Direct evidence on men's physical presence at sessions is limited; positive-masculinity behaviours (accompanying spouse, caring for other children) are reported as a minority pattern.	No specific data were reported in this study on men's own time constraints relative to vaccination.	Control household transportation/care finances in 53.2% of households overall (98.3% in Belel, 65.7% in Touboro); financing transportation is men's most common form of involvement, and its absence is directly linked to missed appointments.	Positioned as household authority/gatekeeper for vaccination decisions in 26.8% of households overall (100% in Belel).
Household	Vaccination-related decisions are made jointly by both parents in 56.4% of households, by the mother alone in 32.1%, and by the father alone in 9.5% (42.4% in Belel).	No specific data were reported in this study on household size or composition in relation to vaccination timing.	Wealth tertile is the strongest overall predictor of complete vaccination (aOR = 2.22, third vs first tertile); unstable household income lowers the odds (aOR = 0.65); joint spousal financial control trends toward better coverage (aOR = 1.45, p = 0.074, not significant).	Cohabiting ("union libre") households show lower complete vaccination than married households (aOR = 0.40); fear of adverse events following immunization (AEFI) is cited as a reason for incomplete vaccination (14.0% overall, prominent in Wum), alongside cultural/religious reasons (30.6%) and spousal refusal (18.4%) in Wum.
Community	CHWs carry out mobilization, defaulter tracing and catch-up	Inconvenient session scheduling is a significant	Vaccine stock-outs and cold-chain deficiencies are reported structural	Community leader endorsement of vaccination (75% overall) is

Level of analysis	Labour	Time	Resources	Culture
	vaccination largely on a voluntary basis.	predictor across models (aOR = 0.22 for sessions rarely/never convenient vs always, overall model); travel time exceeding 60 minutes reduces the odds three-fold in southern districts (aOR = 0.29).	weaknesses; informal payments are reported by 3.2% of respondents overall (10.6% in Kumbo West).	significantly associated with complete vaccination in southern districts (aOR = 3.08); social sanctions linked to vaccination status are almost absent (0.6%).

aOR: adjusted odds ratio.

Findings on service access were similarly organized according to the modified Penchansky and Thomas framework of access [10], which distinguishes six dimensions: accessibility, availability, accommodation (adequacy), affordability, acceptability, and awareness (Table 7).

Table 7
Study findings organized according to the modified Penchansky and Thomas framework of access [10].

Dimension	Definition	Study findings
Accessibility	Geographic/physical fit between the service location and clients' locations.	Children living < 5 km from the vaccinating facility are 2.2 times more likely to be fully vaccinated than those 5–15 km away in southern districts (aOR = 2.23); travel time exceeding 60 minutes reduces the odds three-fold (aOR = 0.29).
Availability	Relationship of the volume and type of services (staffing, stock) to client needs.	Vaccine stock-outs are significantly associated with lower complete vaccination in northern districts (aOR = 0.42); facility closure or staff absence on the scheduled day multiplies the risk of incomplete vaccination six-fold in southern districts (aOR = 0.17); cold-chain deficiencies and CHW understaffing are reported as structural weaknesses.
Accommodation (Adequacy)	Fit between how services are organized (hours, scheduling) and clients' ability to accommodate these arrangements.	Inconvenient session scheduling is the strongest supply-side predictor of incomplete vaccination overall (aOR = 0.22 for sessions rarely/never convenient vs always); fixed weekday-morning sessions conflict with women's competing activities, including chores.
Affordability	Relationship between service costs, direct and indirect, and clients' ability to pay.	Household wealth is the strongest overall predictor of complete vaccination (aOR = 2.22, third vs first tertile); fathers control transport/care finances in 53.2% of households versus 16.8% for mothers; informal payments are reported by 3.2% of respondents overall (10.6% in Kumbo West) despite the official free-of-charge policy.
Acceptability	Fit between clients' attitudes and the actual characteristics of providers/services.	Paternal-authorization requirements (26.8% overall, 100% in Belel) constrain women's autonomous use of services; community leader endorsement is significantly associated with vaccination in southern districts (aOR = 3.08); fear of adverse events following immunization and cultural/religious reasons are cited as reasons for incomplete vaccination, notably in Wum; cohabiting households show lower vaccination than married households (aOR = 0.40).
Awareness	Users' awareness of the service, and the service's awareness of the population's needs; effective communication.	Lack of information is the most-cited reason for non-vaccination (26.7%); 14.7% of respondents overall do not know at which ages vaccination is most important; exposure to vaccination messaging is significantly associated with complete vaccination in all three regression models; CHWs and health staff are the dominant information sources (80.6% and 61.8%, respectively).

aOR: adjusted odds ratio.

Discussion

This study, conducted across six HDs, documents a set of gender- and equity-related barriers that compromise access to and use of routine immunization services. With an overall complete age-appropriate vaccination coverage of 73.4%, major disparities persist between districts, ranging from 58.8% in Belel to 96.9% in Kumbo West. This aligns with national concerns; although Cameroon's official vaccination coverage stood at 75% for MCV1 (the proxy for full immunisation) in 2025 [13], the annual EPI reveals pronounced variations and inconsistencies in coverage across different regions and health districts [14]. These results suggest that vaccination coverage inequalities are not random but are affected by social, economic, geographic and institutional determinants, with gender being a cross-cutting component.

One of the most consistent findings is that mothers are almost exclusively the caregivers who bring children for vaccination (95.5% of cases), yet the decision to proceed is frequently subject to paternal authorisation. In Belel, 100% of mothers reported being unable to take their child for vaccination if the husband objects, and across all districts, 26.8% of respondents indicated that providers required paternal permission to vaccinate a child. This mirrors a UNICEF synthesis across 29 countries identifying women's limited decision-making autonomy as one of the most frequently documented barriers to vaccination in LMICs [15]. A similar pattern was previously observed in Cameroon during COVID-19 vaccination, where women showed statistically higher non-vaccination rates, partly attributable to dependence on spousal decisions [9]. The Cameroon Baptist Convention Health Services'(CBCHS) Immunisation Program conducted an immunisation-related gender-barrier assessment in 10 HDs in the Northwest and Southwest regions and reported that caregivers of unvaccinated children are 9.4 times more likely to cite spousal disapproval as a barrier than caregivers of vaccinated children. [16].

This configuration affirms that, on health matters, the household functions as a structurally unequal space of negotiation, in which women carry the moral responsibility for vaccination without fully holding the decision-making levers, including financial resources. In northern districts, this pattern is institutionalised: mothers control finances for transport and care in only 1.7% of cases in Belel and 2.5% in Touboro. Regression analysis suggests that households where both parents jointly control financial resources tend to vaccinate more completely (aOR = 1.45; 95%CI 0.96–2.18), although this association did not reach conventional significance (p = 0.074), consistent with previous report by Musuka et al., indicating that women's empowerment (decision-making power, financial access, freedom of movement) is strongly correlated with higher child vaccination rates [7].

Men should not, however, be reduced to a role of obstacles. Where present, their participation is a key facilitator: financing transportation is their most frequently cited form of involvement, and its absence directly creates a barrier to access. The aforementioned CBCHS immunization-barriers assessment further that health services tend to overlook male engagement even though men remain the main

economic support enabling women's access to services [17]. Distinct profiles of positive masculinity emerged across regions. They include fathers systematically accompanying their spouse, caring for other children during her absence, or acting as role models within their community. Although these supportive behaviors currently represent a minority within the broader population, study participants emphasized their viability as a strategic lever for driving social and behavioral change (SBC). and, although minority, represent mobilizable levers for community engagement strategies.

Competing activities women or mothers have, that translate into limited time available for vaccination constitute a structural barrier to vaccination that is systematically under-estimated in coverage analyses. Seasonal agricultural work, water and firewood collection, small trade, and domestic responsibilities mechanically reduce mothers' availability for morning-scheduled sessions. These findings converge with evidence identifying unpaid domestic workload as one of the most consistent gender barriers globally [15]. Regression analysis confirms the importance of service availability: caregivers reporting that sessions are never or rarely scheduled at convenient times have children five times less likely to be fully vaccinated than those with consistently convenient scheduling (aOR = 0.22; 95%CI 0.08–0.60; p = 0.003).

Household wealth is among the strongest predictors of complete vaccination in this study; children in the third wealth tertile are 2.2 times more likely to be fully vaccinated than those in the first tertile (aOR = 2.22; 95%CI 1.32–3.72; p = 0.002). Poverty operates through several complementary mechanisms documented qualitatively: inability to finance transportation, heightened vulnerability to schedule disruption, other indirect costs like paying for weighing measurements, and substitution of routine vaccination with campaign-based vaccination perceived as less costly, at the expense of schedule completeness. These observations are consistent with evidence that children from the poorest households are far more likely to be under-vaccinated or zero-dose [18].

Distance to the health facility is also a structuring factor, particularly in southern districts, where children from communities located less than 5 km from the facility are 2.2 times more likely to be fully vaccinated than those 5–15 km away (aOR = 2.23; 95%CI 1.00–4.94; p = 0.048), and travel times exceeding 60 minutes reduce the odds of complete vaccination three-fold (aOR = 0.29; 95%CI 0.09–0.91; p = 0.033), consistent with a systematic review by Bangura et al., highlighting the effect of geographic barriers, to immunization access [19]. Household vulnerability compounds these gender inequalities: unstable income is associated with reduced odds of complete vaccination (aOR = 0.65; 95%CI 0.43–0.98; p = 0.041), and three population groups (poor households, displaced/nomadic populations, and geographically isolated communities) were consistently identified qualitatively as most exposed. In the North-West, the security context linked to the socio-political crisis adds a further dimension of inaccessibility; conflict-related disruption of health systems is well documented to disproportionately affect the most vulnerable populations, particularly women and children [20, 21], and the CBCHS assessment confirms that fear of violence, roadblocks and attacks on facilities limits access to vaccination services in these regions [17].

Community leader endorsement of vaccination (75% overall) was significantly associated with complete vaccination in southern districts (aOR = 3.08; 95%CI 1.33–7.16; p = 0.009), underscoring the role of community social capital, consistent with literature on traditional and religious leaders as vectors of health norms [6]. In northern districts, leader endorsement did not emerge as a significant determinant in the multivariable model, plausibly because the paternal-authorization pattern dominates over community influence in these contexts. The near-total absence of social sanctions linked to vaccination status (99.5%) combined with generally positive vaccine attitudes (96.6% considered vaccines safe) attests that vaccine hesitancy, in the strict sense, is not the principal driver of under-vaccination in these districts; non-vaccination results more from structural constraints than ideological opposition, echoing a previous Cameroonian report by Amani et al., indicating that vaccine refusal is often the product of contextual factors (including misinformation, relational dependence, loss of confidence following negative experiences) rather than a principled stance [9].

Exposure to vaccination messaging in the preceding six months was significantly associated with complete vaccination in all models, with caregivers receiving no messages showing three-fold lower odds overall (aOR = 0.29; 95%CI 0.12–0.67; p = 0.004) and eight-fold lower odds in southern districts (aOR = 0.12; 95%CI 0.04–0.34; p < 0.001), supporting the structuring role of communication on vaccination demand, consistent with a recent systematic review by Ekezie et al., reporting that community mobilization, trust-building and culturally adapted messaging substantially improve vaccination uptake [22]. CHWs and health staff were by far the most frequently cited sources of information (80.6% and 61.8%, respectively), far ahead of digital media (6.7%) and radio/television (4.6%), underscoring both the strength of proximity-based channels and their under-use of broader media in these rural and peri-urban contexts.

Fixed weekday morning scheduling of vaccination sessions emerged as a major determinant of incomplete vaccination across all models. Vaccine stock-outs, reported by 12.6% of respondents overall, were significantly associated with lower complete vaccination in northern districts (aOR = 0.42; 95% CI 0.18–0.98; p = 0.045), consistent with previous reports by Saidu et al. on immunisation data-management and logistics weaknesses in the Cameroonian EPI [23]. Facility closure or staff absence on the scheduled day multiplied the odds of incomplete vaccination in southern districts by 6 (aOR = 0.17; 95% CI 0.03–0.88; p = 0.035). CHWs, whose role in mobilization, defaulter tracing and catch-up sessions is unanimously recognized as indispensable, work voluntarily in conditions that compromise sustained engagement, compounded in some settings by a lack of recognition as full partners by facility-based health staff.

Birth in a health facility was among the most robust predictors of complete vaccination across all models (aOR = 2.36; 95%CI 1.68–3.30; p < 0.001 overall; aOR = 1.90; 95%CI 1.29–2.81 in northern districts), reflecting the effect of first contact with the formal health system: mothers who give birth in a health facility have more opportunities to receive information on the vaccination schedule, benefit from postnatal follow-up facilitating timely first-dose vaccination, and develop trust with providers. With

home-birth rates exceeding 57% in Belel and Touboro, expanding facility-based delivery is an important indirect lever for improving vaccination coverage.

Two counter-intuitive findings deserve attention. First, Kumbo West, despite belonging to the conflict-affected North-West region recorded the highest coverage (96.9%), suggesting that strong local organization and community social capital can, to some extent, offset difficult security conditions; conflict-affected districts should therefore not be reduced to their security context alone, and local resilience factors merit further documentation. Secondly, the absence of a significant sex difference in complete vaccination across the sample ($p = 0.15$, contrasts with the review by Musuka et al., on gender-based vaccination inequalities [7] and may reflect a largely non-gendered vaccination decision once a child is born, with household-level determinants (resources, maternal autonomy, distance) outweighing the child's biological sex. Limited statistical power at the sub-group level, however, cannot rule out smaller or highly localized differences.

Limitations

Several methodological limitations should be considered. The cross-sectional design precludes causal inference between the identified factors and complete vaccination. Vaccination status relied primarily on documentary verification, but caregiver recall was accepted when documentation was unavailable, introducing potential recall bias; the proportion of households with uncertain vaccination status (2.9% overall, 11.2% in Wum) further limits interpretation for that district. Social-desirability bias is inherent to questions on gender roles, paternal authorization, perceived vaccine safety and institutional practices, partially mitigated through empathetic, non-leading interview techniques and confidential FGD settings. Finally, the purposive selection of six districts, excluding underserved urban settings, including slums, limits generalizability to that specific fragile context. These limitations are however offset by the methodological strengths of triangulating quantitative (1,451 households), qualitative (24 key-informant interviews and 12 FGDs) and geographically diverse data. Standard errors in the logistic regression models were not adjusted for the multi-stage cluster sampling design, which may have led to underestimated confidence intervals for some associations. The internal consistency of the composite female-autonomy index (Cronbach's $\alpha = 0.687$) was slightly below the conventional threshold of 0.70, indicating that this index should be interpreted with some caution.

Conclusions

This mixed-methods cross-sectional study, conducted in six health districts of Cameroon, describes an immunization system under strain, structured by gender inequalities, cumulative economic and geographic barriers, and persistent institutional deficiencies. Vaccination is almost exclusively carried out by mothers, yet its exercise remains subordinate to paternal authorization and financial support, particularly in northern districts, where all surveyed mothers in Belel reported being unable to vaccinate without spousal consent. This double vulnerability (moral responsibility without decision-making autonomy or resources) is compounded by availability constraints specific to women. Household wealth

and distance to the health facility are the two strongest independent predictors of complete vaccination, and inconvenient session scheduling is associated with a five-fold reduction in the odds of complete vaccination. Positive-masculinity profiles, identified in every region, and the pivotal but under-supported role of community health workers, represent mobilizable levers. Given that vaccine hesitancy appears to play a limited role (96.6% of caregivers consider vaccines safe, and community leader support is generally favourable), improving coverage sustainably in Cameroon's most disadvantaged districts requires an integrated, gender-responsive and equity-focused approach, tailored to specific contexts, including insecurity in the North-West, pastoral mobility in the northern regions, and insularity in the South-West.

Declarations

Ethics approval and consent to participate

The study received ethical approval from Cameroon's National Ethics Committee for Human Health Research (N°2026/04/1907/CE/CNERSH/SP/SPA), administrative authorization from the Ministry of Public Health, and agreement from the participating health district authorities. Informed consent was obtained from all participants; parental/guardian consent and participant assent were obtained for participants aged under 21 years. All data collection was performed in accordance with Declaration of Helsinki.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

EF, EN and CT: conceptualization, formal analysis, writing the original draft, supervision.CT, DM, NR, EN : methodologyCT, NDD, SOBK and TD: data curation, formal analysis, article review and reviewPT: overall supervisionAll authors read and approved the final manuscript.

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Data Availability

The datasets analyzed during the current study are available from the corresponding author on reasonable request.

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