

Preconception care utilization and geographic disparities in conflict-affected Tigray, Ethiopia: a community-based cross-sectional study

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Abstract

Background

Preconception care (PCC) enhances maternal and newborn health outcomes. In conflict-affected areas where healthcare is disrupted, women encounter obstacles in accessing maternal health services, which reduces PCC utilization. This study explored PCC usage, geographic disparities, and associated factors among women in conflict-affected Tigray, Ethiopia.

Methods

A community-based cross-sectional survey was carried out from September to November 2025 in 32 districts across six accessible zones. Women with children aged 24–36 months were selected using stratified multistage cluster sampling. The receipt of 15 recommended interventions before the index pregnancy was categorized as no, suboptimal, or optimal PCC utilization. Because the proportional-odds assumption was violated, generalized ordered logistic regression was used to estimate adjusted odds ratios (aORs) and 95% confidence intervals (CIs) for two cumulative thresholds.

Results

Among 9,511 participants, 74.7% reported no PCC, 6.1% suboptimal PCC, and 19.2% optimal PCC. Optimal utilization ranged from 0.4% to 61.0% across districts. Compared with the Eastern Zone, women in all other zones had higher adjusted odds of PCC utilization; the strongest association was observed in the Southeast (aOR 7.30 at both thresholds). Women aged 25–34 years (aOR 1.13) and ≥ 35 years (aOR 1.25) had higher odds than women aged 15–24 years. Internally displaced women had higher odds than host-community women (aOR 1.80). Ownership of one, two, or three types of electronic communication devices was positively associated with utilization (aOR range: 1.18–3.48), as was living within 4 hours' walking distance of a health centre or hospital (aOR range: 1.30–1.46).

Conclusions

PCC utilization was low and geographically unequal in conflict-affected Tigray. Recovery strategies should integrate PCC into routine primary and reproductive health services, prioritize districts with the lowest coverage, strengthen community outreach, use inclusive communication approaches, and address physical barriers to care.

Background

Preconception care (PCC) encompasses biomedical, behavioral, and social interventions delivered before conception to improve the health of women, newborns, and children. Essential elements include

nutritional guidance and supplements, testing and management of chronic and infectious illnesses, vaccine evaluations, family and pregnancy planning counseling, and measures to reduce harmful exposures (1, 2). Evidence indicates that health and risk factors before pregnancy influence neural-tube defects, preterm birth, low birth weight, and longer-term maternal and child health (3). PCC is therefore relevant to global goals on maternal mortality, preventable newborn deaths, and universal access to sexual and reproductive health services.

Despite its potential, PCC remains underused in many low- and middle-income countries. Preventive services are often fragmented across family planning, primary care, and maternal health programmes, and many women first contact the health system after pregnancy recognition. These barriers intensify during armed conflict and humanitarian crises, when facilities are damaged, health workers are displaced, supply chains are interrupted, and limited resources are redirected toward acute care.

Tigray has experienced severe health-system disruption since the armed conflict began in late 2020. Assessments have documented extensive damage to health facilities, population displacement, interruption of essential supplies, and reduced continuity of maternal and reproductive health services (4–6). Women and adolescent girls have also faced conflict-related sexual and gender-based violence, psychological distress, food insecurity, and poor reproductive health outcomes (7, 8). These overlapping exposures may reduce autonomy, continuity of care, and access to preventive services before pregnancy.

Evidence on PCC in conflict-affected settings remains limited. Studies from stable settings identify knowledge, education, prior obstetric experience, media exposure, and geographic access as important determinants, but these relationships may differ where health-system recovery is uneven and humanitarian assistance is targeted to displaced populations. Context-specific evidence is needed to identify underserved districts and population groups and to guide equitable recovery. This study therefore estimated PCC utilization levels, described geographic variation, and examined associated factors among women with young children in conflict-affected Tigray.

Methods

Study design and setting

A community-based cross-sectional study was conducted from September to November 2025 in Tigray Regional State, northern Ethiopia. Six accessible administrative zones were included: Mekelle, Eastern, Central, Northwestern, Southern, and Southeastern. The Western Zone and selected districts in the Northwestern, Central, and Eastern zones were excluded because of security and operational constraints. Exclusions were determined before fieldwork and were unrelated to participants' PCC status.

Study population

Eligible participants were women living in host communities or internally displaced person (IDP) settings who had a child aged 24–36 months at the time of the survey. Women who were seriously ill or unable to provide an informed response during data collection were excluded. When more than one eligible woman lived in a household, one was randomly selected to preserve the independence of observations.

Sample size and sampling

The sample size was determined using the Multiple Indicator Cluster Survey approach (9). Several maternal and child health indicators were considered, and full childhood immunization was used as the reference because its assumed regional prevalence of 59.9% yielded the largest required sample size (10). With 95% confidence, a 12% relative margin of error, a design effect of 5, an average household size of 4.4, and 10% allowance for non-response, the initial requirement was 7,988 households. Proportional allocation across study clusters produced a final surveyed sample of 9,511 households.

A stratified multistage cluster design was used. The six accessible zones formed the primary strata. Districts were selected within zones by simple random sampling; 30% of tabias were then selected within each district, followed by 30% of kushets within each selected tabia. A household listing identified eligible households, and all eligible listed households were approached (Fig. 1).

Data collection and quality assurance

A structured questionnaire was developed in English, translated into Tigrigna, and independently back-translated. Items were adapted from prior PCC studies and from WHO and Ethiopian guidelines. The instrument covered sociodemographic characteristics, displacement status, reproductive history, access to health services and communication media, maternal health service use, PCC awareness, and receipt of specific interventions before the prior pregnancy. Maternal and public health experts reviewed the instrument for content, clarity, and cultural appropriateness. It was pretested with 476 women (5%) outside the study area, after which the wording, sequence, and skip patterns were refined.

Trained health professionals collected data using smartphones with Open Data Kit (ODK), and KoboToolbox was used for questionnaire management, validation, synchronization, and secure data storage. The digital data collection system minimized missing data by enabling real-time submission of completed questionnaires directly to the server. Data collectors and supervisors received three days of training on the protocol, ethics, interviewing, electronic collection, and quality control. Supervisors reviewed completeness and consistency daily, and the central team monitored uploaded records throughout fieldwork.

Variables and outcome definition

The primary outcome was the level of PCC utilization. Explanatory variables included age, marital and educational status, occupation, residence, zone, participant group (IDP or host community), reproductive history, walking time to health facilities, transport access, and household access to radio, television, and mobile telephones.

PCC was assessed using 15 interventions derived from WHO recommendations, the Ethiopian preconception care national guideline, and previous studies (11). The interventions were folic acid supplementation, iron supplementation, nutritional counseling, HIV testing and counseling, malaria prevention, tetanus toxoid immunization, screening for hypertension and diabetes, family-planning counseling, genetic counseling, tobacco and alcohol cessation counseling, weight-management counseling, dental examination, mental-health screening, vaccination review, and pregnancy-planning counseling. Participants were asked whether each intervention had been received before conception and before recognition of the index pregnancy; services received after recognition of the index pregnancy were not counted as PCC.

Utilization was classified hierarchically as: no PCC (none of the 15 interventions); suboptimal PCC (at least one intervention that did not meet the optimal definition); or optimal PCC (folic acid supplementation plus at least one additional recommended intervention). Folic acid supplementation is considered a key intervention for optimal PCC, as studies show that taking folic acid during the periconceptional period can prevent 50–75% of neural tube defects (NTDs) (12).

Walking time was recorded in prespecified categories for descriptive analyses and then collapsed into < 4 hours and ≥ 4 hours for the multivariable model. Household electronic communication access was summarized as the number of device types available (radio, television, or mobile telephone).

Statistical analysis

Data were exported to Stata version 19 for cleaning and analysis. Categorical variables were summarized as frequencies and percentages; continuous variables were summarized using means and standard deviations or medians and interquartile ranges, as appropriate. Cross-tabulations were used to describe variation in PCC utilization across participant characteristics. The outcome was ordinal (none, suboptimal, optimal). A proportional-odds model was initially considered, but the Brant test indicated violation of the proportional-odds assumption ($p < 0.05$). A generalized ordered logistic regression model was therefore fitted using `gologit2` (13). The model estimated two cumulative comparisons: (1) suboptimal or optimal utilization versus no utilization, and (2) optimal utilization versus no or suboptimal utilization. Variables with $p < 0.25$ in the bivariate analysis were included in the multivariable model. Adjusted odds ratios (aORs) and 95% CIs were reported for each threshold. A comprehensive case analysis was performed, considering sampling weights and survey design elements like clustering and stratification. Robust standard errors, calculated at the primary sampling unit level, accounted for clustering due to the multistage design. Model adequacy was evaluated using the Wald test and the

Akaike information criterion; variance inflation factors below 5 indicated acceptable multicollinearity levels. Statistical significance was determined at $p < 0.05$.

Results

Participant characteristics and PCC utilization

A total of 9,511 women were analyzed, corresponding to a 99% response rate. Mean age was 28.8 years (SD 6.2); 89.9% were married, 54.1% lived in rural areas, and 12.3% were IDPs. Approximately 22.4% could not read or write, 36.8% had completed secondary education or higher, and 37.5% of households had access to television or radio (Table 1).

Table 1
Sociodemographic characteristics by preconception care utilization

Level of PCC utilization									
	None		Suboptimal		Optimal		Total		
Variable	n	%	n	%	n	%	n	%	p value
Overall sample	7102	74.7	581	6.1	1828	19.2	9511	100.0	
Zone									
Central	2052	77.3	235	8.8	369	13.9	2656	27.9	< 0.001
Eastern	1467	85.2	85	4.9	170	9.9	1722	18.1	
Mekelle	574	60.8	45	4.8	325	34.4	944	9.9	
Northwest	1985	74.5	148	5.6	533	20.0	2666	28.0	
Southeast	305	49.4	47	7.6	266	43.0	618	6.5	
Southern	719	79.4	21	2.3	165	18.2	905	9.5	
Age category, M = 28.8 years (SD = 6.2)									
15 to 24 years	1900	77.0	148	6.0	421	17.1	2469	26.0	0.008
25 to 34 years	3659	74.3	288	5.9	975	19.8	4922	51.8	
≥ 35 years	1543	72.8	145	6.8	432	20.4	2120	22.3	
Marital status									
Non-married	213	74.5	16	5.6	57	19.9	286	3.0	0.002
Married	6401	74.9	504	5.9	1642	19.2	8547	89.9	
Divorced	348	75.0	40	8.6	76	16.4	464	4.9	
Widowed	53	73.6	8	11.1	11	15.3	72	0.8	
Separated	87	61.3	13	9.2	42	29.6	142	1.5	
Educational status									
Unable to read and write	1519	71.3	130	6.1	480	22.5	2129	22.4	< 0.001
PCC, preconception care; IDP, internally displaced person. Percentages in the Total column are percentages of the overall sample. p-values are from bivariate comparisons.									

Level of PCC utilization									
		None		Suboptimal		Optimal		Total	
Variable		n	%	n	%	n	%	n	% p value
Able to read/write; no formal education		556	74.9	38	5.1	148	19.9	742	7.8
Elementary school		2149	74.5	186	6.4	550	19.1	2885	30.3
Secondary school		2165	77.4	158	5.6	475	17.0	2798	29.4
College and above		713	74.5	69	7.2	175	18.3	957	10.1
Partner's educational status									
Unable to read and write		1180	70.9	115	6.9	370	22.2	1665	17.5 < 0.001
Able to read/write; no formal education		899	78.2	50	4.3	201	17.5	1150	12.1
Elementary school		1649	73.5	130	5.8	465	20.7	2244	23.6
Secondary school		1953	77.1	149	5.9	432	17.0	2534	26.6
College and above		1081	74.4	104	7.2	268	18.4	1453	15.3
I don't know		340	73.1	33	7.1	92	19.8	465	4.9
Religion									
Orthodox		6693	74.5	554	6.2	1738	19.3	8985	94.5 0.013
Muslim		352	79.8	17	3.9	72	16.3	441	4.6
Other (Protestant or Catholic)		57	67.1	10	11.8	18	21.2	85	0.9
Ethnicity									
Tigray		6971	75.8	501	5.4	1729	18.8	9201	96.7 < 0.001
Erob		103	51.8	42	21.1	54	27.1	199	2.1
Other (Kunama, Amhara, or Afar)		28	25.2	38	34.2	45	40.5	111	1.2
PCC, preconception care; IDP, internally displaced person. Percentages in the Total column are percentages of the overall sample. p-values are from bivariate comparisons.									

	Level of PCC utilization								p value
	None		Suboptimal		Optimal		Total		
Variable	n	%	n	%	n	%	n	%	
Occupation									
Housewife	5734	73.9	473	6.1	1548	20.0	7755	81.5	< 0.001
Employed (private or government)	494	73.7	46	6.9	130	19.4	670	7.0	
Merchant	239	74.2	20	6.2	63	19.6	322	3.4	
Other (farmer, daily laborer, student, or unemployed)	635	83.1	42	5.5	87	11.4	764	8.0	
Partner's occupation									
Farmer	3437	74.7	242	5.3	924	20.1	4603	48.4	< 0.001
Employed (private, government, or NGO)	1465	76.4	120	6.3	333	17.4	1918	20.2	
Merchant	527	68.9	62	8.1	176	23.0	765	8.0	
Daily labourer	1024	74.7	81	5.9	265	19.3	1370	14.4	
Other (student or TDF)	649	75.9	76	8.9	130	15.2	855	9.0	
Place of residence									
Rural	3959	77.0	269	5.2	916	17.8	5144	54.1	< 0.001
Urban	3143	72.0	312	7.1	912	20.9	4367	45.9	
Type of study participants									
Host	6360	76.3	452	5.4	1527	18.3	8339	87.7	< 0.001
Internally displaced person (IDP)	742	63.3	129	11.0	301	25.7	1172	12.3	
PCC, preconception care; IDP, internally displaced person. Percentages in the Total column are percentages of the overall sample. p-values are from bivariate comparisons.									

Overall, 7,102 women (74.7%) received no PCC, 581 (6.1%) received suboptimal PCC, and 1,828 (19.2%) received optimal PCC. Descriptive differences were observed by zone, age, marital status, education, occupation, residence, participant group, reproductive history, facility access, and access to communication technologies (Tables 1 and 2).

Table 2
Reproductive, access, and communication characteristics by PCC utilization

	Level of PCC utilization								
	None		Suboptimal		Optimal		Total		
Variable	n	%	n	%	n	%	n	%	p value
Family size									
1 to 4	3909	74.9	319	6.1	989	19.0	5217	54.9	0.325
5 to 8	2946	74.0	246	6.2	790	19.8	3982	41.9	
≥ 9	247	79.2	16	5.1	49	15.7	312	3.3	
Gravidity									
1	1973	76.4	142	5.5	468	18.1	2583	27.2	0.028
2 to 4	3694	73.5	315	6.3	1020	20.3	5029	52.9	
≥ 5	1435	75.6	124	6.5	340	17.9	1899	20.0	
History of twin birth									
Yes	265	73.0	34	9.4	64	17.6	363	4.1	0.027
No	6837	74.7	547	6.0	1764	19.3	8515	95.9	
Number of births									
Nulliparous	626	76.5	49	6.0	143	17.5	818	8.6	0.716
Primiparous	1711	75.1	131	5.8	436	19.1	2278	24.0	
2 to 4 births	3590	74.0	305	6.3	957	19.7	4852	51.0	
≥ 5 births	1175	75.2	96	6.1	292	18.7	1563	16.4	
History of stillbirth									
No	6860	74.5	567	6.2	1777	19.3	9204	96.8	0.212
Yes	242	78.8	14	4.6	51	16.6	307	3.2	
History of abortion									
No	6302	74.5	503	5.9	1657	19.6	8462	89.0	0.011
Yes	800	76.3	78	7.4	171	16.3	1049	11.0	
PCC, preconception care; ITN, insecticide-treated net. Totals vary for variables with skip patterns or missing responses. p-values are from bivariate comparisons.									

	Level of PCC utilization								
	None		Suboptimal		Optimal		Total		
Variable	n	%	n	%	n	%	n	%	p value
Distance to the nearest health post									
≤ 30 minutes	4181	75.2	360	6.5	1016	18.3	5557	58.4	< 0.001
31 to 60 minutes	1776	71.6	156	6.3	548	22.1	2480	26.1	
≥ 61 minutes	1145	77.7	65	4.4	264	17.9	1474	15.5	
Distance to the nearest health center/hospital									
≤ 60 minutes	3926	74.2	411	7.8	951	18.0	5288	55.6	< 0.001
61 to 239 minutes	2079	72.2	124	4.3	676	23.5	2879	30.3	
≥ 240 minutes	1097	81.6	46	3.4	201	15.0	1344	14.1	
Public transport access to the nearest health center/hospital									
No	4748	74.6	402	6.3	1214	19.1	6364	66.9	0.454
Yes	2354	74.8	179	5.7	614	19.5	3147	33.1	
Household access to television or radio									
No	4520	76.0	344	5.8	1080	18.2	5944	62.5	< 0.001
Yes	2582	72.4	237	6.6	748	21.0	3567	37.5	
Frequency of television/radio use									
Always/every day	2024	71.2	209	7.4	609	21.4	2842	79.7	0.009
At least once a week	392	77.2	17	3.3	99	19.5	508	14.2	
Less than once a week	135	78.0	7	4.0	31	17.9	173	4.9	
PCC, preconception care; ITN, insecticide-treated net. Totals vary for variables with skip patterns or missing responses. p-values are from bivariate comparisons.									

Level of PCC utilization									
	None		Suboptimal		Optimal		Total		
Variable	n	%	n	%	n	%	n	%	p value
Not at all	31	70.5	4	9.1	9	20.5	44	1.2	
Total	2582	72.4	237	6.6	748	21.0	3567	100.0	
Mobile telephone ownership									
No	2733	76.6	192	5.4	641	18.0	3566	37.5	0.002
Yes	4369	73.5	389	6.5	1187	20.0	5945	62.5	
Received health communication by mobile phone									
No	3400	75.6	260	5.8	840	18.7	4500	75.7	< 0.001
Yes	969	67.1	129	8.9	347	24.0	1445	24.3	
Total	4369	73.5	389	6.5	1187	20.0	5945	100.0	
Number of household electronic communication device types									
None	2380	77.5	172	5.6	521	16.9	3073	32.3	< 0.001
One	2515	74.3	192	5.7	675	20.0	3382	35.6	
Two	2107	73.7	188	6.6	562	19.7	2857	30.0	
Three	100	50.3	29	14.6	70	35.2	199	2.1	
The household owns an ITN									
No	4347	74.6	337	5.8	1144	19.6	5828	61.3	0.139
Yes	2755	74.8	244	6.6	684	18.6	3683	38.7	
ITN use among owners									
No	384	81.0	31	6.5	59	12.4	474	12.9	0.001
PCC, preconception care; ITN, insecticide-treated net. Totals vary for variables with skip patterns or missing responses. p-values are from bivariate comparisons.									

	Level of PCC utilization								p value
	None		Suboptimal		Optimal		Total		
Variable	n	%	n	%	n	%	n	%	
Yes	2371	73.9	213	6.6	625	19.5	3209	87.1	
Total	2755	74.8	244	6.6	684	18.6	3683	100.0	
PCC, preconception care; ITN, insecticide-treated net. Totals vary for variables with skip patterns or missing responses. p-values are from bivariate comparisons.									

Awareness and geographic variation

Only 33.5% of participants reported having heard of PCC. Among women who were aware of PCC, 89.9% intended to use it in a future pregnancy. Nevertheless, only 25.3% of all participants had received any PCC intervention (Fig. 2).

Optimal utilization varied substantially by zone: 43.0% in the Southeast, 34.4% in Mekelle, 20.0% in the Northwest, 18.2% in the Southern Zone, 13.9% in the Central Zone, and 9.9% in the Eastern Zone. Across districts, optimal utilization ranged from 61.0% in Ayder to 0.4% in Tahtay Koraro. Other high-coverage districts included Hintalo (54.8%), Seharti (53.7%), and Laelay Koraro (51.9%); Tsirae Wemberta (0.8%), Adihaki (1.4%), and Laelay Adiyabo (1.6%) were among the lowest (Figs. 3 and 4).

Factors associated with PCC utilization

In the generalized ordered logistic model, zone, age, participant group, household electronic communication devices, and walking time to a health center or hospital were independently associated with PCC utilization (Table 3). The proportional-odds assumption was relaxed for zone, number of device types, and facility walking time.

Table 3
Multivariable predictors of preconception care utilization

Predictor	Suboptimal/optimal vs no, aOR (95% CI)	p value	Optimal vs no/suboptimal, aOR (95% CI)	p value
Zone				
Eastern	Reference		Reference	
Central	1.70 (1.44–2.00)	< 0.001	1.31 (1.09–1.57)	0.003
Mekelle	2.82 (2.32–3.42)	< 0.001	3.53 (2.89–4.31)	< 0.001
Northwest	2.01 (1.71–2.37)	< 0.001	2.01 (1.71–2.37)	< 0.001
Southeast	7.30 (5.93–9.00)	< 0.001	7.30 (5.93–9.00)	< 0.001
Southern	1.71 (1.37–2.13)	< 0.001	2.08 (1.65–2.62)	< 0.001
Age category				
15–24 years	Reference		Reference	
25–34 years	1.13 (1.01–1.27)	0.038	1.13 (1.01–1.27)	0.038
≥ 35 years	1.25 (1.09–1.43)	0.002	1.25 (1.09–1.43)	0.002
Participant group				
Host community	Reference		Reference	
Internally displaced person	1.80 (1.55–2.08)	< 0.001	1.80 (1.55–2.08)	< 0.001
Residence				
Rural	Reference		Reference	
Urban	1.02 (0.90–1.15)	0.784	1.02 (0.90–1.15)	0.784
Electronic communication device types				
None	Reference		Reference	
One	1.18 (1.05–1.33)	0.006	1.18 (1.05–1.33)	0.006
Two	1.35 (1.17–1.56)	< 0.001	1.22 (1.05–1.42)	0.011
aOR, adjusted odds ratio; CI, confidence interval. Robust standard errors accounted for clustering. Reference categories are shown explicitly.				

Predictor	Suboptimal/optimal vs no, aOR (95% CI)	p value	Optimal vs no/suboptimal, aOR (95% CI)	p value
Zone				
Three	3.48 (2.54–4.77)	< 0.001	2.33 (1.67–3.23)	< 0.001
Walking time to nearest health center/hospital				
≥ 4 hours	Reference		Reference	
< 4 hours	1.46 (1.24–1.73)	< 0.001	1.30 (1.09–1.56)	0.004
Constant	0.08 (0.07–0.10)	< 0.001	0.07 (0.05–0.08)	< 0.001
aOR, adjusted odds ratio; CI, confidence interval. Robust standard errors accounted for clustering. Reference categories are shown explicitly.				

For the first threshold (suboptimal or optimal versus no PCC), women in the Central (aOR 1.70, 95% CI 1.44–2.00), Mekelle (2.82, 2.32–3.42), Northwest (2.01, 1.71–2.37), Southeast (7.30, 5.93–9.00), and Southern (1.71, 1.37–2.13) zones had higher odds than women in the Eastern Zone. For the second threshold (optimal versus no or suboptimal PCC), the corresponding estimates were 1.31 (1.09–1.57), 3.53 (2.89–4.31), 2.01 (1.71–2.37), 7.30 (5.93–9.00), and 2.08 (1.65–2.62).

Compared with women aged 15–24 years, those aged 25–34 years (aOR 1.13, 95% CI 1.01–1.27) and ≥ 35 years (aOR 1.25, 95% CI 1.09–1.43) had higher odds at both thresholds. IDPs had higher odds than host-community women (1.80, 1.55–2.08). Device ownership showed a dose-response pattern: compared with no device, ownership of one device type was associated with an aOR of 1.18 at both thresholds; two types with aORs of 1.35 and 1.22; and three types with aORs of 3.48 and 2.33. Living < 4 hours' walking distance from a health centre or hospital was associated with greater utilization (aOR 1.46 for threshold 1 and 1.30 for threshold 2). Urban residence was not independently associated with utilization (aOR 1.02, $p = 0.784$).

Discussion

This large community-based study found that PCC utilization in conflict-affected Tigray was very low: almost three-quarters of women reported no preconception intervention, and fewer than one in five met the study definition of optimal utilization. Coverage differed sharply between zones and districts. Geographic location, older age, IDP status, household access to electronic communication devices, and shorter walking time to a health facility were the principal independent correlates.

The low uptake is consistent with studies from northern Ethiopia and broader evidence from Africa indicating that PCC remains poorly integrated into routine services (14–17). However, it is lower than

estimates reported in more stable or urban Ethiopian settings, including Addis Ababa, as well as pooled estimates from Ethiopia and sub-Saharan Africa (18–22).

Differences in definitions and populations may account for part of the variation. In Tigray, however, the destruction of health infrastructure, the displacement of health workers and communities, disrupted supply chains, and the prioritization of emergency care provide a plausible additional explanation (4–6). Preventive services that require anticipatory counseling may be particularly vulnerable when routine primary health care is interrupted.

The geographic gradient was one of the strongest findings. Optimal PCC ranged from below 1% in some districts to more than 50% in others, and adjusted associations persisted after accounting for measured individual and household characteristics. Geographic inequalities in maternal-health service use have also been reported in India and China (23, 24). In Tigray, variation may reflect uneven restoration of facilities, workforce availability, transport networks, insecurity, and the distribution of humanitarian programs. The results support district-level planning rather than a uniform regional response. Eastern and Central districts with very low coverage warrant particular attention, while higher-performing districts may provide operational lessons for service integration.

Awareness was limited, although the intention to use PCC was high among women who had heard of it. Studies in Ethiopia, Nigeria, and Malawi similarly identify limited knowledge as a barrier (25–28). This gap suggests that demand-side communication should accompany service restoration. Radio, mobile messaging, and community health-worker counseling could provide practical information before pregnancy, but the observed association with device ownership also signals a digital divide. Communication strategies should therefore combine digital channels with face-to-face outreach so that women without devices are not further disadvantaged (29–31).

IDPs had higher adjusted odds of PCC utilization than women in host communities. This finding should not be interpreted as evidence that displacement improves health. A plausible explanation is that some IDP populations received targeted humanitarian reproductive-health services or had more frequent contact with outreach teams, while dispersed host communities relied on weakened routine services. Because the study did not measure program exposure, this interpretation remains inferential. Recovery plans should protect services for displaced populations while extending comparable preventive care to underserved host communities.

Older women were more likely to use PCC, consistent with studies in Ethiopia and other African settings (18, 32, 33). Greater reproductive experience, prior complications, and repeated contact with maternal-health services may increase risk perception and exposure to counseling. Younger women, including adolescents and women entering a first pregnancy, may have fewer opportunities to receive preconception information and should be specifically included in school, youth, family-planning, and community health programs.

Ownership of electronic communication devices was also closely associated with PCC utilization. Women with access to radio, television, or mobile phones were significantly more likely to use PCC services. This finding supports research indicating that mass media and digital health interventions improve maternal health knowledge and boost service use (34–36). Exposure to electronic media likely raises reproductive health awareness, improves understanding of services, and encourages timely health actions. These findings underscore the importance of digital health in boosting maternal service utilization. Nonetheless, to ensure equitable PCC strategies in resource-limited and conflict-affected regions, disparities in access to health information need to be addressed.

Walking time to a health center or hospital remained independently associated with utilization. Distance, poor roads, limited transport, and conflict-related insecurity can make preventive visits costly even when services are nominally free (37–39). Outreach through health posts, mobile clinics, integrated family-planning encounters, and decentralized counselling may reduce this access penalty. PCC should also be incorporated into postnatal and child-health contacts, which provide opportunities to prepare women for subsequent pregnancies.

The study has several strengths, including a large sample size, coverage of six zones and 32 districts, inclusion of both IDP and host-community women, electronic quality controls, and the use of a generalized ordered logistic model when the proportional odds assumption was not supported. Limitations should also be considered. The cross-sectional design precludes causal inference. PCC receipt was self-reported for a pregnancy that could have occurred up to 36 months earlier, creating potential recall and social desirability bias. The Western Zone and insecure districts were excluded, which could reduce regional representativeness and lead to an underestimation of barriers in the most inaccessible areas. The operational definition of optimal PCC emphasizes folic acid along with one other component, and this may not be directly comparable to definitions used in other studies. Residual confounding is possible because service availability, humanitarian program exposure, household wealth, and conflict intensity were not directly measured.

Conclusions

PCC utilization in conflict-affected Tigray was very low and marked by pronounced geographic inequality. Post-conflict health-system recovery should integrate PCC into primary care, family planning, postnatal care, and community outreach; prioritize districts with the lowest coverage; and reduce travel barriers through decentralized services. Communication through radio and mobile platforms may extend reach, but non-digital approaches remain essential for households without devices. Prospective and implementation research is needed to evaluate integrated PCC delivery and to clarify how humanitarian and routine services can equitably serve both displaced and host communities.

Abbreviations

AIC

Akaike information criterion
ANC
antenatal care
aOR
adjusted odds ratio
CI
confidence interval
IDP
internally displaced person
IQR
interquartile range
ITN
insecticide-treated net
MICS
Multiple Indicator Cluster Survey
ODK
Open Data Kit
PCC
preconception care
PNC
postnatal care
SD
standard deviation
VIF
variance inflation factor
WHO
World Health Organization.

Declarations

Ethics approval and consent to participate

Ethical approval was granted by the Tigray Health Research Institute (reference 001/77/2015). Administrative permission was secured from regional and local authorities, and verbal informed consent was provided by those who approved the participation of internally displaced persons and women in conflict zones. Each participant provided verbal informed consent prior to the interview. Participation was voluntary, with confidentiality and anonymity preserved throughout data collection and analysis. Participants were also informed they could refuse or withdraw at any time without facing any consequences.

Consent for publication

Not applicable.

Availability of data and materials

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

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

YT contributed to conceptualization, study design, methodology, statistical analysis, mapping, data visualization, validation, and manuscript drafting. MA contributed to the study design, data visualization, and review and editing of the manuscript. YW reviewed and edited the manuscript. MME contributed to statistical analysis and data visualization. LZ contributed to conceptualization, validation, supervision, and critical revision of the manuscript. WCC contributed to conceptualization, study design, statistical analysis, mapping, data visualization, validation, supervision, and critical revision of the manuscript. All authors read and approved the final manuscript.

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Authors' information

Not applicable.

References

1. Dean SV, Lassi ZS, Imam AM, Bhutta ZA. Preconception care: closing the gap in the continuum of care to accelerate improvements in maternal, newborn and child health. *Reprod Health*. 2014;11 Suppl 3(Suppl 3):S1.
2. Braspenningx S, Haagdorens M, Blaumeiser B, Jacquemyn Y, Mortier G. Preconceptional care: a systematic review of the current situation and recommendations for the future. *Facts Views Vis Obgyn*. 2013;5(1):13-25.
3. Stephenson J, Heslehurst N, Hall J, Schoenaker D, Hutchinson J, Cade JE, et al. Before the beginning: nutrition and lifestyle in the preconception period and its importance for future health. *Lancet*. 2018;391(10132):1830-41.
4. Gebregziabher M, Amdeselassie F, Esayas R, Abebe Z, Silvia H, Teklehaimanot AA, et al. Geographical distribution of the health crisis of war in the Tigray region of Ethiopia. *BMJ Glob Health*. 2022;7(4).
5. Haftu H, Weledegebriel MG, Gebre-Egziabher A, Gebrehiwot T, Zenebe D, Berhe B, et al. Experience Sharing on Continuity of Healthcare Services in Internally Displaced Peoples: The Case of Tigray War Crisis. *Risk Manag Healthc Policy*. 2023;16:2197-208.
6. Gufue ZH, Haftu HK, Alemayehu Y, Tsegay EW, Mengesha MB, Dessalegn B. Damage to the public health system caused by war-related looting or vandalism in the Tigray region of Northern Ethiopia. *Front Public Health*. 2024;12:1271028.
7. Fisseha G, Gebrehiwot TG, Gebremichael MW, Wahdey S, Meles GG, Gezae KE, et al. War-related sexual and gender-based violence in Tigray, Northern Ethiopia: a community-based study. *BMJ Glob Health*. 2023;8(7).
8. Woldegebriel AG, Gebrehiwot GG, Teka AG, Gebreyesus HA, Weldeclassie TT, Desta AA, et al. High manifestations of food insecurity and hunger among pregnant and lactating women during post-conflict in Tigray, Ethiopia: a community-based study. *BMC Pregnancy Childbirth*. 2024;24(1):385.
9. UNICEF. Multiple Indicator Cluster Survey manual. New York: UNICEF; 2006.
10. Gebretnsae H, Ayele B, Gebresilassie F, Hadgu T, Kahsay H, Aregay A, et al. Vaccination status and its determinants among children aged 12-23 months in Tigray, northern Ethiopia: A zero-inflated Poisson regression analysis. *PLoS One*. 2025;20(7):e0327854.
11. Ministry of Health E. National preconception care guideline: ensuring a risk-free conception experience. Addis Ababa: Ministry of Health; . 2024.
12. Blom HJ, Shaw GM, den Heijer M, Finnell RH. Neural tube defects and folate: case far from closed. *Nature Reviews Neuroscience*. 2006;7(9):724-31.
13. Williams R. Understanding and interpreting generalized ordered logit models. *The Journal of Mathematical Sociology*. 2016;40(1):7-20.
14. Gebretsadik GG, Kahsay AB, Biratu AK, Gessessew A, Lassi ZS, Mulugeta A. Preconception care services in Northern Ethiopia: A qualitative exploration of awareness, experiences, challenges,

- opportunities, and prospects. *PLoS One*. 2025;20(12):e0337548.
15. Gebretsadik GG, Biratu AK, Bayray Kahsay A, Gessessew A, Lassi ZS, Segni H, Mulugeta A. Preconception care uptake and risk factors for adverse pregnancy outcomes among pregnant women in Tigray, northern Ethiopia: A community-based cross-sectional study. *PLoS One*. 2025;20(11):e0336255.
 16. Tekalign T, Lemma T, Silesh M, Lake EA, Teshome M, Yitna T, Awoke N. Mothers' utilization and associated factors of preconception care in Africa, a systematic review and meta-analysis. *PLoS One*. 2021;16(7):e0254935.
 17. Asresu TT, Hailu D, Girmay B, Abrha MW, Weldearegay HG. Mothers' utilization and associated factors in preconception care in northern Ethiopia: a community based cross sectional study. *BMC Pregnancy Childbirth*. 2019;19(1):347.
 18. Girma A, Bedada A, Kumbi S. Utilization of preconception care and associated factors among pregnant women attending ANC in private MCH Hospitals in Addis Ababa, Ethiopia. *BMC Pregnancy Childbirth*. 2023;23(1):649.
 19. Abneh AA, Getahun WT, Agmassie GA, Gelaw SS, Kassie TD. The magnitude of preconception care utilization and associated factors among women in Ethiopia: systematic review and meta-analysis, 2024. *BMC Pregnancy Childbirth*. 2025;25(1):259.
 20. Woldeyohannes D, Tekalegn Y, Sahiledengle B, Hailemariam Z, Erkal D, Zegeye A, et al. Preconception care in sub-Saharan Africa: A systematic review and meta-analysis on the prevalence and its correlation with knowledge level among women in the reproductive age group. *SAGE Open Med*. 2023;11:20503121231153511.
 21. Fetena N, Negash A, Kebede A, Sertsu A, Nega A, Nigussie K, et al. Utilization of preconception care and associated factors among pregnant mothers in Fiche Town, Central Ethiopia: a community-based cross-sectional study 2021. *Front Glob Womens Health*. 2023;4:1159693.
 22. Goshu YA, Ayele AS, Erega BB, Mitiku AK, Yitayew AE, Belay DM, et al. A systematic review and meta-analysis of utilization and associated factors of preconception care among women of reproductive age in Ethiopia. *Discover Social Science and Health*. 2026.
 23. Tripathi P, Chakrabarty M, Singh A, Let S. Geographic disparities and determinants of full utilization of the continuum of maternal and newborn healthcare services in rural India. *BMC Public Health*. 2024;24(1):3378.
 24. Wu X, Fang H, Xu T. Inequality in preconception care utilization based on the opportunity inequality framework: evidence from explained machine learning. *Front Public Health*. 2026;14:1732192.
 25. Demeke M, Yetwale F, Mulaw Z, Yehualashet D, Gashaw A, Agegn Mengistie B. Knowledge and attitude towards preconception care and associated factors among women of reproductive age with chronic disease in Amhara region referral hospitals, Ethiopia, 2022. *BMC Womens Health*. 2024;24(1):184.
 26. Fekene DB, Woldeyes BS, Erena MM, Demisse GA. Knowledge, uptake of preconception care and associated factors among reproductive age group women in West Shewa zone, Ethiopia, 2018. *BMC*

- Womens Health. 2020;20(1):30.
27. Fadare RI, Ajayi K, Bello CB, Ojo FT, Obinatu V. Perceptions, attitude, and practice of undergraduates towards pre-conceptional care in Ado-Ekiti, Nigeria. *Afr J Reprod Health*. 2023;27(6s):129-37.
 28. Munthali M, Chiumia IK, Mandiwa C, Mwale S. Knowledge and perceptions of preconception care among health workers and women of reproductive age in Mzuzu City, Malawi: a cross-sectional study. *Reprod Health*. 2021;18(1):229.
 29. Lassi ZS, Dean SV, Mallick D, Bhutta ZA. Preconception care: delivery strategies and packages for care. *Reprod Health*. 2014;11 Suppl 3(Suppl 3):S7.
 30. Fatema K, Lariscy JT. Mass media exposure and maternal healthcare utilization in South Asia. *SSM Popul Health*. 2020;11:100614.
 31. Wang Y, Etowa J, Ghose B, Tang S, Ji L, Huang R. Association Between Mass Media Use and Maternal Healthcare Service Utilisation in Malawi. *J Multidiscip Healthc*. 2021;14:1159-67.
 32. Demisse TL, Aliyu SA, Kitila SB, Tafesse TT, Gelaw KA, Zerihun MS. Utilization of preconception care and associated factors among reproductive age group women in Debre Birhan town, North Shewa, Ethiopia. *Reprod Health*. 2019;16(1):96.
 33. Setegn Alie M, Alemu T, Alemayehu D, Negesse Y, Gebremariam A. Preconception care utilization and associated factors among reproductive age women in Mizan-Aman town, Bench Sheko zone, Southwest Ethiopia, 2020. A content analysis. *PLoS One*. 2022;17(8):e0273297.
 34. Kabir MR. How do traditional media access and mobile phone use affect maternal healthcare service use in Bangladesh? Moderated mediation effects of socioeconomic factors. *PLoS One*. 2022;17(4):e0266631.
 35. Nie J, Unger JA, Thompson S, Hofstee M, Gu J, Mercer MA. Does mobile phone ownership predict better utilization of maternal and newborn health services? a cross-sectional study in Timor-Leste. *BMC Pregnancy and Childbirth*. 2016;16(1):183.
 36. De P, Pradhan MR. Effectiveness of mobile technology and utilization of maternal and neonatal healthcare in low and middle-income countries (LMICs): a systematic review. *BMC Women's Health*. 2023;23(1):664.
 37. Marchant T, Beaumont E, Makowiecka K, Berhanu D, Tessema T, Gautham M, et al. Coverage and equity of maternal and newborn health care in rural Nigeria, Ethiopia and India. *Cmaj*. 2019;191(43):E1179-e88.
 38. Chama-Chiliba CM, Koch SF. Utilization of focused antenatal care in Zambia: examining individual- and community-level factors using a multilevel analysis. *Health Policy Plan*. 2015;30(1):78-87.
 39. M'Hamdi H I, van Voorst SF, Pinxten W, Hilhorst MT, Steegers EA. Barriers in the Uptake and Delivery of Preconception Care: Exploring the Views of Care Providers. *Matern Child Health J*. 2017;21(1):21-8.

Figures

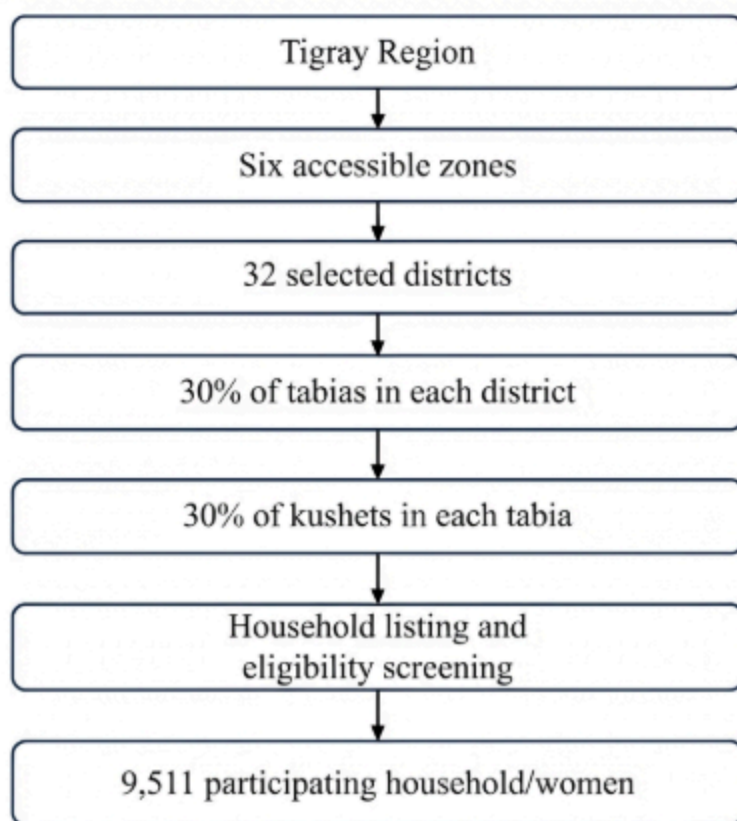


Figure 1

Multistage sampling framework in Tigray, Ethiopia, 2025. Six accessible zones were included. Districts were sampled within zones, followed by listing 30% of tabias and 30% of kushets, and the enrollment of 9,511 eligible women.

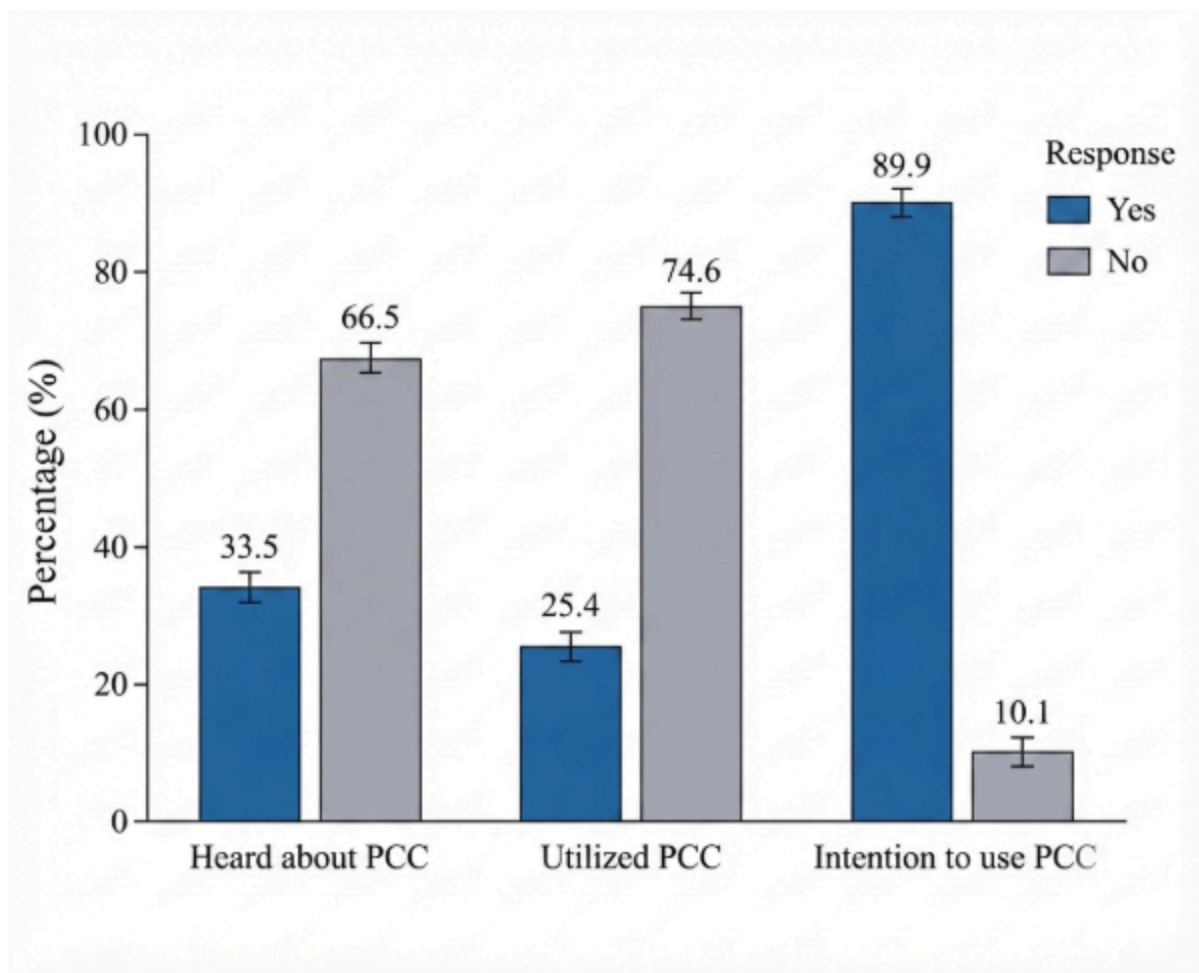


Figure 2

Awareness, intention, and any preconception of care use. Awareness and any PCC use are reported for all participants; intention to use PCC is reported among women who had heard of PCC.

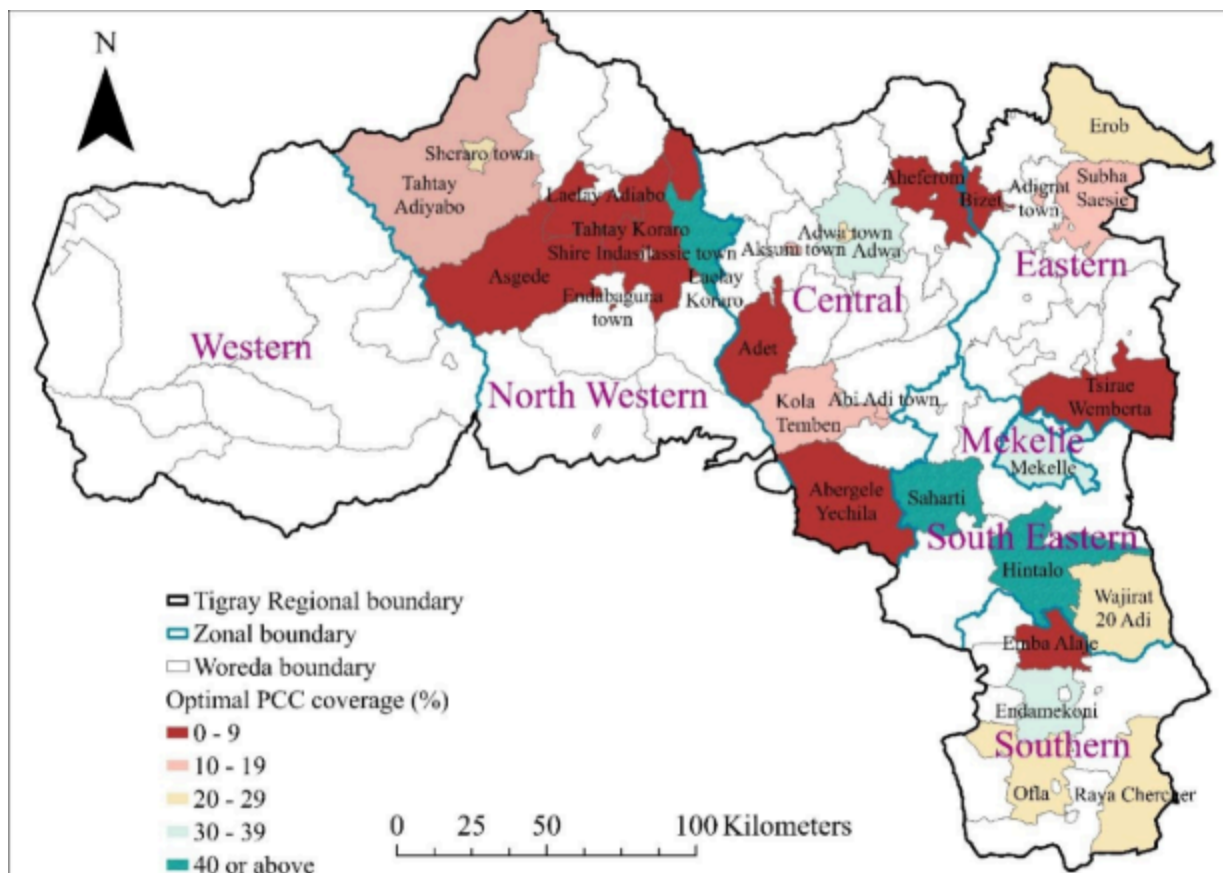


Figure 3

Spatial distribution of optimal preconception care utilization. Colors indicate district-level optimal PCC coverage. Unshaded areas were neither surveyed nor included in the mapped analysis.

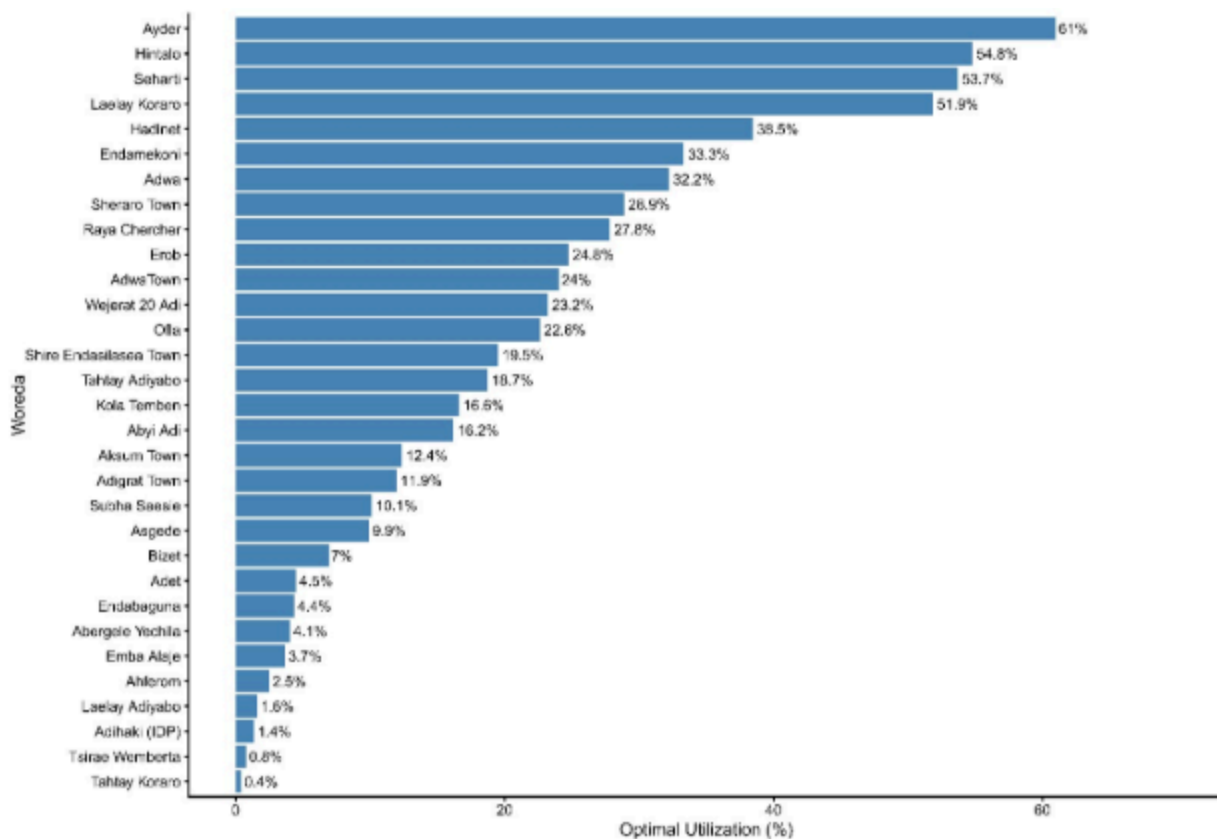


Figure 4

District-level optimal preconception care utilization. Bars show the percentage of women who meet the study's definition of optimal PCC in each surveyed district.