

Place Matters Along the Maternal-Care Continuum: Socioeconomic Inequality, Regional Heterogeneity, and Stage-Specific Attrition in Ethiopia, EDHS 2024–25

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Abstract

Background: Maternal health services are often reported as separate coverage indicators, although protection across pregnancy, childbirth, and the early postnatal period depends on women remaining connected to care across successive stages. Ethiopia has expanded maternal health service coverage, yet national averages can conceal large socioeconomic and geographic differences. This study examined retention through a cumulative maternal-care continuum in Ethiopia and tested whether contemporary regional location remained associated with continuum progression after accounting for women's education and household wealth.

Methods: We analyzed the 2024–25 Ethiopia Demographic and Health Survey using the Individual Recode file and the DHS complex survey design. The analytic universe comprised 5,021 women with a most recent live birth in the 24 months preceding the survey. A cumulative continuum was defined as Stage 1: four or more antenatal-care contacts (ANC4+); Stage 2: ANC4+ plus facility delivery; and Stage 3: ANC4+ plus facility delivery plus maternal postnatal care within two days. Descriptive estimates were produced nationally, by education (no formal education vs any formal education), wealth (bottom 40% vs upper 60%), and the contemporary 14-region geography. Survey-weighted logistic regression estimated odds ratios (ORs), and design-based Wald tests assessed the global contribution of region. Conditional-transition models separately examined ANC4+ among all eligible births, facility delivery among women reaching ANC4+, and timely postnatal care among women reaching ANC4+ and facility delivery.

Results: National retention declined from 53.5% at ANC4+ to 42.5% at ANC4+ plus facility delivery and 26.1% at the complete continuum. Socioeconomic disparities were pronounced. Women with any formal education had coverage of 63.6%, 54.3%, and 34.6% across the three stages, compared with 35.9%, 21.9%, and 11.4% among women with no formal education. Corresponding coverage among the upper 60% of the wealth distribution was 68.6%, 59.1%, and 37.1%, compared with 31.1%, 17.7%, and 9.8% among the bottom 40%. Regional Stage-3 coverage ranged from 64.4% in Addis Ababa to 3.0% in Somali. After adjustment for education and wealth, region remained globally associated with ANC4+ ($F=11.0$, $p<0.001$), ANC4+ plus facility delivery ($F=11.2$, $p<0.001$), and the complete continuum ($F=5.14$, $p<0.001$). Regional heterogeneity also persisted for each conditional transition, including timely postnatal care after ANC4+ and facility delivery ($F=3.44$, $p<0.001$). At that final transition, wealth was no longer statistically associated with timely postnatal care ($OR=1.14$, $p=0.472$), whereas education remained associated ($OR=1.56$, $p=0.015$) and regional heterogeneity persisted. Distinct regional attrition profiles were evident: Somali showed very low entry into ANC4+ but high conditional progression to facility delivery among women who reached ANC4+, followed by low postnatal retention; Addis Ababa showed near-universal progression through facility delivery but substantial attrition before timely postnatal care.

Conclusions: Maternal-care inequality in Ethiopia is not adequately characterized by national coverage or by socioeconomic gradients alone. Education, household wealth, and place each mark different dimensions of continuity, and their relative importance changes across the care pathway.

Regional heterogeneity persists after adjustment for education and wealth and remains evident even at the postnatal transition, where the wealth association is no longer statistically detectable. Maternal-health strategies should therefore monitor cumulative retention, identify the transition at which women are lost in each region, and combine socioeconomic equity interventions with geographically differentiated service-delivery responses.

Keywords: maternal health; continuum of care; antenatal care; facility delivery; postnatal care; regional inequality; education; wealth; Ethiopia; Demographic and Health Survey

Introduction

Maternal survival and well-being depend not on a single encounter with the health system but on a sequence of contacts extending from pregnancy through childbirth and the early postnatal period. The continuum-of-care framework emphasizes both continuity over time and continuity across levels and locations of service delivery. In this framework, antenatal care, skilled or facility-based childbirth care, and postnatal care are not isolated achievements; they are linked opportunities to prevent, detect, and manage risk and to sustain contact with women and newborns across periods in which needs can change rapidly (Kerber et al., 2007).

Global guidance similarly treats pregnancy, childbirth, and the postnatal period as connected components of high-quality, woman-centred care. World Health Organization recommendations emphasize meaningful antenatal contacts, evidence-based and respectful intrapartum care, and routine postnatal care for women and newborns, with the broader objective of improving both outcomes and experience of care (World Health Organization [WHO], 2016, 2018, 2022). The policy implication is straightforward: expanding any one service is necessary but insufficient when substantial numbers of women are lost before the next stage.

Ethiopia has invested for decades in primary health care, community-based service delivery, health extension, referral systems, and expansion of maternal health services. The country's Health Sector Transformation Plan II placed quality, equity, universal health coverage, and improved reproductive, maternal, newborn, child, adolescent, and youth health among national priorities (Federal Ministry of Health [FMoH], 2020). The 2024–25 Ethiopia Demographic and Health Survey (EDHS) provides the most recent nationally representative opportunity to assess how women are progressing through the maternal-care pathway under the country's contemporary administrative geography (Ethiopian Statistical Service [ESS] & ICF, 2026).

Previous Ethiopian research has repeatedly documented incomplete continuity of maternal care. A systematic review and meta-analysis estimated pooled complete-continuum utilization at approximately one quarter and identified education, employment, early antenatal initiation, birth preparedness, pregnancy intention, and autonomy among associated factors (Addisu et al., 2022). Other analyses show that continuity varies by wealth, education, residence, and administrative region, and that attrition can be especially pronounced at the postpartum stage (Tiruneh et al., 2022; Chaka, 2023). More recent inequality analyses likewise show large economic, educational, residential, and subnational disparities in the use of antenatal, skilled birth, and postnatal services (Wuneh et al., 2022; [PMA Ethiopia inequality study], 2025).

Much of the existing literature, however, leaves three analytical problems only partially resolved. First, separate coverage indicators can obscure the cumulative nature of continuity. A woman counted as receiving postnatal care in an independent indicator is not necessarily a woman who also achieved adequate antenatal contact and facility delivery. A cumulative construction therefore answers a

different question: what proportion of women remained connected through all preceding stages? Second, a single complete-continuum outcome can obscure where attrition occurs. Two regions can have similar final coverage while losing women at very different transitions. Third, socioeconomic and geographic inequalities are often examined separately, making it difficult to determine whether observed regional heterogeneity is largely compositional or remains after accounting for measured education and wealth.

These distinctions are particularly important in Ethiopia. The country's geography encompasses large differences in settlement pattern, urbanization, transport, health-service infrastructure, pastoralist mobility, conflict exposure, referral connectivity, local health-system capacity, and social context. Region therefore should not be interpreted as a single causal exposure. It is better understood as a contextual marker that bundles multiple place-specific conditions. The scientific question is not whether a regional coefficient proves a causal 'place effect,' but whether substantial geographic heterogeneity remains after accounting for two major socioeconomic dimensions—education and household wealth.

The present study therefore extends the maternal-care continuum in four ways. First, it constructs a strictly cumulative three-stage pathway in which every later stage includes only women retained from all preceding stages. Second, it quantifies educational and wealth gradients in cumulative retention. Third, it describes the continuum across Ethiopia's 14 regions, including regional absolute losses and conditional retention. Fourth, it uses survey-weighted logistic regression and design-based omnibus Wald tests to determine whether regional heterogeneity persists after adjustment for education and wealth and to identify whether the pattern changes across conditional transitions.

Our central hypothesis was that place would remain associated with maternal-care continuity after socioeconomic adjustment. A second, more exploratory hypothesis was that the relative importance of education, wealth, and region would not be constant across the pathway. Rather, different barriers may dominate entry into ANC, continuation to facility delivery, and timely postnatal care. This stage-specific approach is intended to move the analysis from the broad observation that disparities exist to a more programmatically useful question: where, for whom, and in which regions does continuity break?

Methods

Study design and data source

This was a cross-sectional secondary analysis of the 2024–25 EDHS. The EDHS is a nationally representative household survey implemented using a stratified multistage cluster sampling design. This analysis used the women's Individual Recode (IR) file and retained the original DHS sampling weight, primary sampling unit, and stratification variables. The detailed EDHS report and survey documentation provide the full sampling and fieldwork procedures (ESS & ICF, 2026).

The analysis followed a replicate-first, extend-second workflow. Before any subgroup or inferential analysis, the national continuum was required to reproduce previously validated estimates within a tolerance of ± 1.0 percentage point. This validation gate reduced the risk that subsequent regional or socioeconomic results reflected an unnoticed change in the universe or indicator coding.

Analytic population

The analytic universe consisted of women whose most recent live birth occurred in the 24 months preceding the survey and for whom valid survey weight, primary sampling unit, stratum, and contemporary region were available. The final analytic sample contained 5,021 observations,

representing approximately 4,951 design-weighted recent births. Education, wealth, and region were observed for all 5,021 women included in the inferential analysis; consequently, the fully adjusted models did not incur complete-case loss from these covariates.

Definition of the cumulative maternal-care continuum

The continuum was intentionally cumulative rather than a set of independent service indicators. Three nested stages were defined:

- Stage 1 — ANC4+: the woman had four or more antenatal-care contacts/visits for the index birth.
- Stage 2 — ANC4+ and facility delivery: the woman met Stage 1 and delivered the index birth in a health facility.
- Stage 3 — complete continuum: the woman met Stages 1 and 2 and received maternal postnatal care within two days of delivery.

By construction, Stage 3 could never exceed Stage 2 and Stage 2 could never exceed Stage 1. This monotonicity rule was checked programmatically before estimation. The use of ANC4+ reflects the indicator available for longitudinal comparison within the analytical workflow; it should not be interpreted as implying that four contacts represent the current WHO standard, which recommends a minimum of eight contacts for a positive pregnancy experience (WHO, 2016).

Socioeconomic stratification

Education was dichotomized as no formal education versus any formal education. Household wealth was derived from the DHS wealth index and dichotomized as the bottom 40% (poorest and poorer quintiles) versus the upper 60% (middle, richer, and richest quintiles). These contrasts were selected to produce interpretable equity comparisons with adequate subgroup sample sizes. They are descriptive social-position markers rather than causal treatments.

Contemporary regional geography

Regional analyses used the contemporary 2024–25 administrative geography represented in the EDHS region variable. Fourteen regions/city administrations were analyzed: Tigray, Afar, Amhara, Oromia, Somali, Benishangul-Gumuz, Central Ethiopia, Sidama, South West Ethiopia, South Ethiopia, Gambela, Harari, Addis Ababa, and Dire Dawa. No historical reconstruction of the former Southern Nations, Nationalities, and Peoples' Region was used because the purpose of this analysis was contemporary cross-sectional geographic differentiation.

Descriptive analysis

Survey-weighted percentages and 95% confidence intervals were estimated for each cumulative stage nationally and by region. Socioeconomic analyses estimated the same stages by education and wealth. Absolute loss was decomposed into: (1) 100% minus Stage 1, representing failure to reach ANC4+; (2) Stage 1 minus Stage 2, representing loss between ANC4+ and facility delivery; and (3) Stage 2 minus Stage 3, representing loss between facility delivery and timely maternal postnatal care. Conditional retention was calculated as Stage 2 divided by Stage 1 and Stage 3 divided by Stage 2. These two metrics answer different questions: absolute loss quantifies percentage points lost from the original cohort, whereas conditional retention describes progression among women who reached the immediately preceding stage.

Inferential analysis

Survey-weighted logistic regression models were estimated using the complex survey design and a quasibinomial specification. Odds ratios, 95% confidence intervals, and p values were obtained for

education, wealth, and region. Oromia was selected as the regional reference category because it is the largest population region and provides a substantively useful comparison; it was not selected because it represented either the highest or lowest performance.

The model sequence was hierarchical. Crude cumulative-stage models estimated education-only, wealth-only, and region-only associations. Socioeconomic models included education and wealth simultaneously. Fully adjusted cumulative-stage models included education, wealth, and the 14-level region factor. Design-based omnibus Wald tests evaluated the joint contribution of region; individual region-versus-Oromia coefficients were interpreted only after the global test supported regional heterogeneity.

A second set of models decomposed the cumulative outcome into conditional transitions: (1) ANC4+ among all eligible recent births; (2) facility delivery among women who had reached ANC4+; and (3) timely maternal postnatal care among women who had reached ANC4+ and facility delivery. Each conditional transition was modeled first with region alone and then with education, wealth, and region. This decomposition was used to distinguish geographic disadvantage in entering the pathway from disadvantage in remaining connected after a preceding stage had already been achieved.

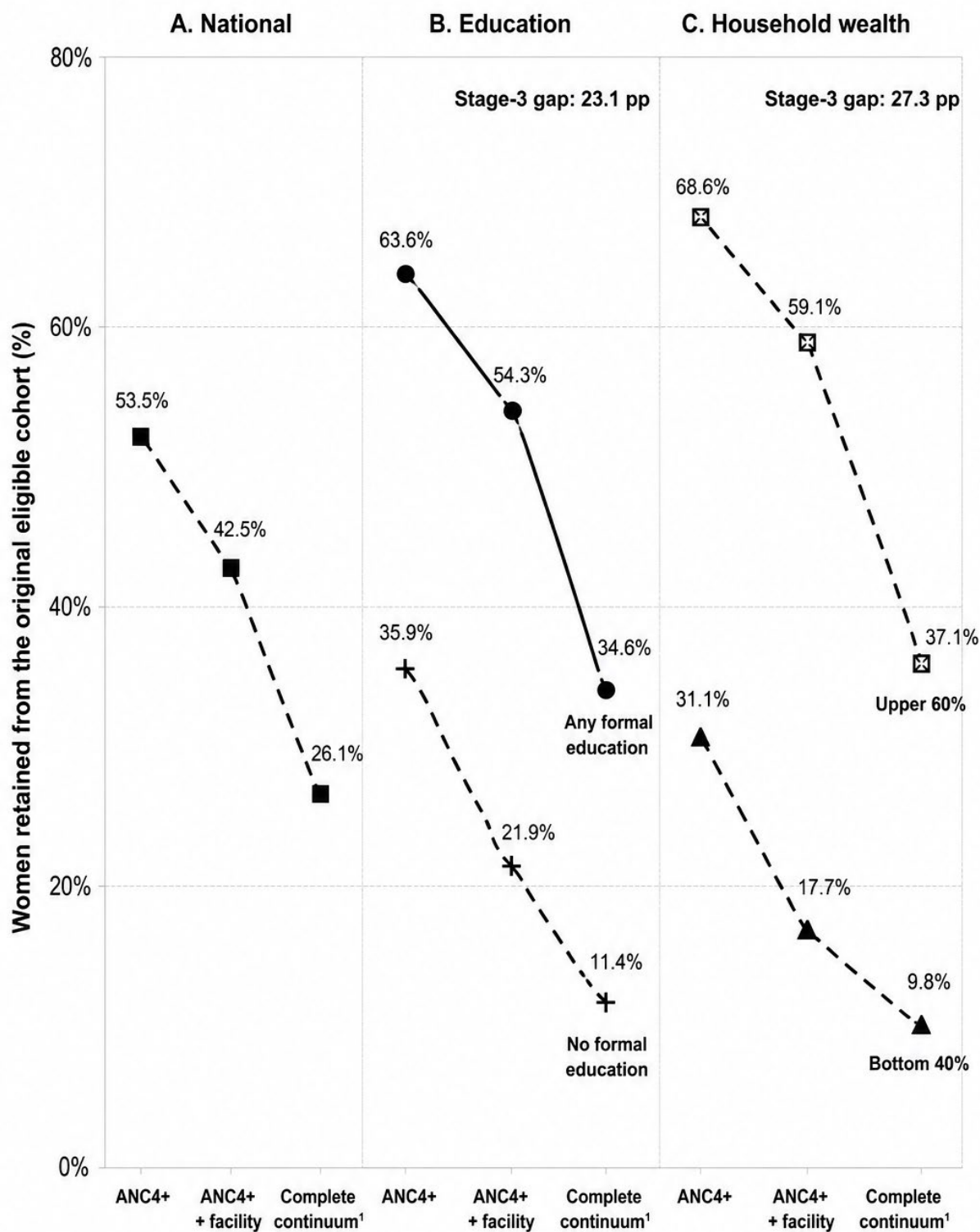
Sparse-cell and model-stability audit

Because some regions have relatively small unweighted samples and some outcomes approach very high or very low prevalence, unweighted events and non-events were audited by region. Cells with fewer than 10 events or non-events were flagged for cautious interpretation. This issue was especially relevant to facility delivery after ANC4+ in Addis Ababa and Harari, where very few women who reached ANC4+ subsequently delivered outside a facility. The global region tests are therefore emphasized over isolated extreme regional odds ratios.

Interpretation framework

Odds ratios are interpreted as ratios of odds, not as risk ratios or statements that women were a given number of times 'more likely.' Region is treated as a contextual marker encompassing multiple measured and unmeasured place-specific conditions. Adjustment for education and wealth therefore does not establish an independent causal effect of place. The analysis identifies residual regional heterogeneity conditional on these measured socioeconomic characteristics. Because the EDHS is observational and cross-sectional with respect to the analytic associations, causal language is avoided.

Figure 1. Construction of the cumulative maternal-care continuum and analytic decomposition, Ethiopia EDHS 2024–25



Universe: women with most recent live birth in the preceding 24 months. Complete continuum – ANC4+ facility delivery + maternal PNC within 2 days. Stage-3 gaps are absolute percentage-point differences between the displayed groups. Source: Ethiopia DHS 2024-25

Results

National retention through the continuum

The national continuum showed substantial attrition across successive stages. An estimated 53.5% of women reached ANC4+, 42.5% both reached ANC4+ and delivered in a facility, and 26.1% completed the three-stage continuum. Thus, 46.5 percentage points of the original cohort were lost before ANC4+; an additional 11.0 percentage points were lost between ANC4+ and facility delivery; and a further 16.4 percentage points were lost between facility delivery and timely maternal postnatal care. Overall, approximately three quarters of recent births did not complete the defined continuum.

The pattern illustrates why independent service indicators can be misleading when the research question concerns continuity. The Stage-3 estimate is not simply national postnatal-care coverage. It represents the subset of women who received timely maternal postnatal care after also meeting the ANC4+ and facility-delivery requirements.

Socioeconomic stratification

Education produced a large and persistent gradient at every cumulative stage. Among women with no formal education, coverage was 35.9% at Stage 1, 21.9% at Stage 2, and 11.4% at Stage 3. Among women with any formal education, corresponding estimates were 63.6%, 54.3%, and 34.6%. The absolute education gap was therefore 27.7 percentage points at ANC4+, widened to 32.4 points at Stage 2, and remained 23.1 points at completion.

The wealth gradient was still larger descriptively. Coverage among the bottom 40% was 31.1%, 17.7%, and 9.8% across Stages 1–3, compared with 68.6%, 59.1%, and 37.1% among the upper 60%. The absolute wealth gaps were 37.5, 41.4, and 27.3 percentage points, respectively. All education and wealth differences at the three cumulative stages were statistically significant in the design-based comparisons.

The socioeconomic results suggest two related mechanisms of inequality. First, large disparities are already present at entry into adequate antenatal contact. Second, inequality compounds as women move from antenatal contact to facility delivery. By the complete continuum, only about one in ten women in the bottom 40% and one in nine women with no formal education remained retained through all three stages.

Table 1. National and socioeconomic retention through the cumulative maternal-care continuum, Ethiopia EDHS 2024–25

Characteristic	ANC4+ % (95% CI)	ANC4+ + facility delivery % (95% CI)	Complete continuum % (95% CI)	Unweighted n
National	53.5 (50.1–56.9)	42.5 (38.8–46.1)	26.1 (23.1–29.1)	5,021
Education				
No formal education	35.9 (31.4–40.4)	21.9 (17.7–26.1)	11.4 (8.5–14.3)	1,985
Any formal education	63.6 (60.2–67.1)	54.3 (50.5–58.1)	34.6 (31.1–38.0)	3,036
Difference, pp (95% CI)	27.7 (22.8–32.6)	32.4 (27.7–37.1)	23.1 (19.6–26.7)	—
Household wealth				
Bottom 40%	31.1 (27.2–35.1)	17.7 (14.2–21.2)	9.8 (7.4–12.3)	2,676
Upper 60%	68.6 (65.1–72.1)	59.1 (55.2–63.1)	37.1 (33.2–41.0)	2,345
Difference, pp (95% CI)	37.5 (32.5–42.4)	41.4 (36.6–46.2)	27.3 (23.1–31.5)	—

Notes: Universe: women with the most recent live birth in the preceding 24 months. Stage 1 = ANC4+; Stage 2 = ANC4+ and facility delivery; complete continuum = ANC4+ and facility delivery and maternal postnatal care within 2 days. Each later stage is cumulative and includes only women retained from all preceding stages. Differences are absolute percentage-point contrasts: any formal education minus no formal education, and upper 60% minus bottom 40% of household wealth. All six equity-gap tests $p < 0.001$. Estimates and 95% confidence intervals account for the complex survey design. National estimates shown here are the internally consistent estimates from the certified continuum analytic dataset.

Source: Ethiopia Demographic and

Regional variation in cumulative coverage

Regional heterogeneity was striking. Complete-continuum coverage ranged from 64.4% in Addis Ababa to 3.0% in Somali, a difference of more than 60 percentage points. Central Ethiopia ranked second at 33.6%, followed by Amhara at 30.1%, Dire Dawa at 28.5%, and Gambela at 28.1%. At the lower end, South West Ethiopia (13.8%), Afar (12.7%), and Somali (3.0%) had markedly lower completion.

The regional ranking at Stage 3, however, conceals different pathways to the final result. Somali had only 12.8% ANC4+ coverage and 10.9% Stage-2 coverage. In contrast, Addis Ababa had 96.2% ANC4+ and 94.1% Stage-2 coverage before falling to 64.4% at Stage 3. Central Ethiopia progressed from 59.0% to 53.0% to 33.6%, while Afar declined from 46.0% to 23.8% to 12.7%. These patterns indicate that very different transition-specific losses can lead to a common final outcome.

Table 2. Regional cumulative maternal-care coverage and conditional retention across Ethiopia's contemporary 14 regions, EDHS 2024–25

Region	ANC4+ % (95% CI)	ANC4+ + facility delivery % (95% CI)	Complete continuum % (95% CI)	ANC4+ → facility retention %	Facility → PNC retention %
Tigray	57.2 (51.0–63.4)	47.8 (40.9–54.7)	24.8 (20.1–29.4)	83.6	51.9
Afar	46.0 (37.8–54.2)	23.8 (17.7–30.0)	12.7 (8.5–16.9)	51.8	53.4
Amhara	62.0 (55.4–68.7)	51.9 (45.0–58.7)	30.1 (24.0–36.2)	83.6	58.1
Oromia	49.3 (42.4–56.3)	34.9 (27.4–42.5)	23.8 (17.6–30.0)	70.9	68.2
Somali	12.8 (6.3–19.2)	10.9 (4.1–17.6)	3.0 (0.3–5.7)	85.0	27.2
Benishangul-Gumuz	57.9 (48.4–67.3)	48.8 (38.6–59.0)	23.5 (15.8–31.2)	84.3	48.2
Central Ethiopia	59.0 (51.0–67.0)	53.0 (44.5–61.5)	33.6 (25.3–41.8)	89.8	63.4
Sidama	41.7 (34.9–48.6)	35.7 (29.0–42.4)	23.3 (16.7–29.8)	85.4	65.2
South West Ethiopia	48.4 (39.3–57.5)	36.1 (25.5–46.6)	13.8 (9.3–18.4)	74.5	38.3
South Ethiopia	47.2 (38.1–56.2)	35.3 (25.2–45.4)	20.9 (13.6–28.2)	74.8	59.2
Gambela	49.3 (40.7–57.9)	43.6 (35.1–52.1)	28.1 (21.3–34.9)	88.4	64.5
Harari	46.7 (37.8–55.5)	45.0 (35.8–54.2)	22.3 (16.3–28.2)	96.4	49.5
Addis Ababa	96.2 (93.7–98.8)	94.1 (91.3–96.9)	64.4 (54.6–74.2)	97.8	68.5
Dire Dawa	69.5 (62.2–76.8)	61.2 (53.8–68.5)	28.5 (21.2–35.8)	88.0	46.6

Notes: ANC4+ denotes four or more antenatal-care contacts. Cumulative Stage 2 requires both ANC4+ and facility delivery. Complete continuum requires ANC4+, facility delivery, and maternal postnatal care (PNC) within 2 days. ANC4+ → facility retention is the percentage of women reaching ANC4+ who subsequently delivered in a facility while remaining in the cumulative continuum; facility → PNC retention is the percentage reaching cumulative Stage 2 who subsequently received timely maternal PNC. Conditional-retention percentages therefore have different denominators from cumulative coverage estimates. Estimates use Ethiopia's contemporary 14-region geography.

Source: Ethiopia Demographic and Health Survey 2024–25; certified CH04_08C2 continuum analysis.

Regional attrition profiles

Conditional retention revealed a different regional ordering than cumulative coverage. Somali retained 85.0% of women from ANC4+ to facility delivery despite its exceptionally low ANC4+ entry, but only 27.2% of women who reached Stage 2 were retained through timely postnatal care. Harari retained 96.4% from ANC4+ to facility delivery but only 49.5% through the subsequent postnatal transition. Addis Ababa retained 97.8% from ANC4+ to facility delivery and 68.5% through timely postnatal care. Dire Dawa showed 88.0% retention into facility delivery but only 46.6% retention into timely postnatal care.

Absolute loss decomposition complements these conditional measures. Somali lost 87.2 percentage points before ANC4+, making pathway entry the dominant population-level bottleneck. Afar lost 54.0 points before ANC4+ and another 22.2 points between ANC4+ and facility delivery. By contrast, Addis Ababa lost only 3.8 points before ANC4+ and 2.1 points before facility delivery, but 29.7 points between facility delivery and timely postnatal care. Dire Dawa similarly lost 32.7 points at the final transition. These results show that the phrase 'low continuum completion' is programmatically incomplete unless the location of attrition is also specified.

Survey-weighted regression: socioeconomic associations

In models containing education and wealth but not region, any formal education was associated with higher odds of ANC4+ (OR=2.12), Stage 2 (OR=2.82), and complete-continuum attainment (OR=2.80), with $p<0.001$ for each comparison. The upper 60% of the wealth distribution had still larger odds ratios: 3.92 for ANC4+, 5.21 for Stage 2, and 4.13 for the complete continuum, all $p<0.001$.

Adding region attenuated but did not eliminate these socioeconomic associations. In the fully adjusted cumulative-stage models, the education ORs were 1.94 for ANC4+, 2.57 for Stage 2, and 2.56 for complete-continuum attainment; the corresponding wealth ORs were 3.46, 4.65, and 3.67. All remained statistically significant at $p<0.001$. Thus, neither the education nor wealth gradient can be reduced to regional composition alone.

Figure 2. Heatmap of cumulative maternal-care continuum coverage across Ethiopia's 14 contemporary regions, EDHS 2024–25



¹Completed continuum = ANC4+ + facility delivery – maternal PNC within 2 days. Each state is cumulative; State 3 is not an independent PNC prevalence estimate.

Figure 3. Regional attrition heatmap: conditional retention between successive stages of the maternal-care continuum, EDHS 2024–25

A. Absolute attrition

	Lost before ANC4+	ANC4+ → facility loss	Facility → timely PNC loss
Addis Ababa	3.8	2.1	29.7
Central Ethiopia	41.0	6.0	19.4
Amhara	38.0	10.2	21.7
Dire Dawa	30.5	8.3	32.7
Gambela	50.7	5.7	15.5
Tigray	42.8	9.4	23.0
Oromia	50.7	14.4	11.1
Benishangul-Gumuz	42.1	9.1	25.3
Sidama	58.3	6.1	12.4
Harari	53.3	1.7	22.7
South Ethiopia	52.8	11.9	14.4
South West Ethiopia	51.6	12.3	22.2
Afar	54.0	22.2	11.1
Somali	87.2	1.9	7.9

Absolute loss (percentage points)

0 25 50 75 100

B. Conditional retention

	ANC4+ → facility retention	Facility → timely PNC retention
Addis Ababa	97.8	68.5
Central Ethiopia	89.8	63.4
Amhara	83.6	58.1
Dire Dawa	88.0	46.6
Gambela	88.4	64.5
Tigray	83.6	51.9
Oromia	70.9	68.2
Benishangul-Gumuz	84.3	48.2
Sidama	85.4	65.2
Harari	96.4	49.5
South Ethiopia	74.8	59.2
South West Ethiopia	74.5	38.3
Afar	51.8	53.4
Somali	85.0	27.2

Conditional retention (%)

0 25 50 75 100

Regions use the same order as Figure 2. Top panel losses are absolute percentage-point losses from the original eligible cohort; right-panel retention is conditional on reaching the preceding stage. Source: Ethiopia DHS 2024-25

Global tests of regional heterogeneity

The design-based omnibus Wald tests provide the primary inferential evidence that place matters. In region-only models, region was associated with ANC4+ ($F=13.1$, 13 numerator df, $p<0.001$), Stage 2 ($F=18.4$, $p<0.001$), and complete-continuum attainment ($F=9.95$, $p<0.001$). After adjusting simultaneously for education and wealth, regional heterogeneity remained strong for ANC4+ ($F=11.0$, $p<0.001$), Stage 2 ($F=11.2$, $p<0.001$), and the complete continuum ($F=5.14$, $p<0.001$). The attenuation of the F statistics indicates that socioeconomic composition accounts for some geographic differentiation, but the persistence of highly significant global tests shows that it does not account for all of it.

Conditional-transition models produced the same conclusion. After education and wealth adjustment, region remained globally associated with reaching ANC4+ ($F=11.0$, $p<0.001$), facility delivery among women who reached ANC4+ ($F=4.59$, $p<0.001$), and timely postnatal care among women who reached ANC4+ and facility delivery ($F=3.44$, $p<0.001$). Regional heterogeneity therefore persisted at every transition rather than being confined to initial access.

Conditional transitions and the changing socioeconomic pattern

The conditional models reveal that the correlates of continuity change along the pathway. For reaching ANC4+, the fully adjusted education OR was 1.94 and the wealth OR was 3.46, both $p<0.001$. Among women who had already reached ANC4+, any formal education remained associated with facility delivery ($OR=2.32$, $p<0.001$) and upper-60% wealth remained strongly associated ($OR=3.60$, $p<0.001$).

At the final transition, however, the socioeconomic pattern changed. Among women who had already achieved ANC4+ and facility delivery, any formal education remained associated with timely postnatal care, although more modestly ($OR=1.56$, $p=0.015$). The wealth association was small and statistically non-significant ($OR=1.14$, $p=0.472$). Region, in contrast, remained globally associated with timely postnatal care at this same transition ($F=3.44$, $p<0.001$). This should not be interpreted as evidence that place causally replaces wealth. It does show that the measured wealth gradient that strongly differentiates earlier stages is not detectable at the final conditional transition, whereas substantial regional heterogeneity remains.

Selected regional contrasts relative to Oromia

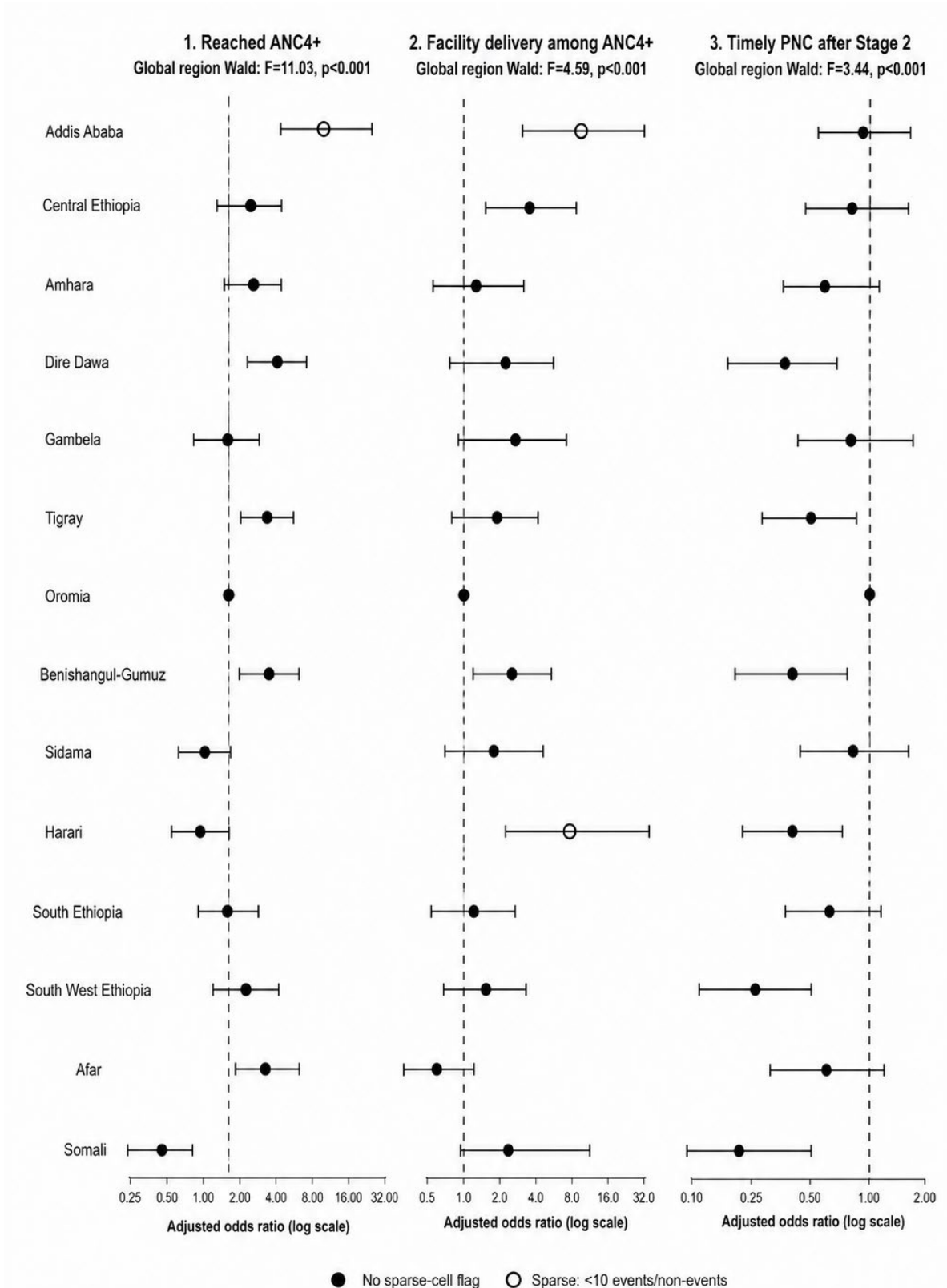
Individual regional coefficients help identify the structure underlying the global tests. Relative to Oromia, and after adjustment for education and wealth, Somali had markedly lower odds of ANC4+ ($OR=0.232$, 95% CI 0.135–0.398; $p<0.001$) and lower odds of completing the full continuum ($OR=0.176$, 95% CI 0.072–0.433; $p<0.001$). Yet among Somali women who had reached ANC4+, the odds ratio for facility delivery was 2.73 (95% CI 0.96–7.77; $p=0.060$), suggesting no statistically established disadvantage at that conditional transition. Among women who reached ANC4+ and facility delivery, Somali had substantially lower odds of timely postnatal care ($OR=0.180$, 95% CI 0.071–0.458; $p<0.001$).

South West Ethiopia illustrates a different pattern. Its adjusted odds of complete-continuum attainment were lower than Oromia (OR=0.554, 95% CI 0.336–0.913; $p=0.021$), but its conditional odds of facility delivery after ANC4+ were not significantly different (OR=1.45, 95% CI 0.779–2.70; $p=0.241$). The principal inferential contrast emerged at timely postnatal care, where the adjusted OR was 0.288 (95% CI 0.152–0.547; $p<0.001$).

Addis Ababa showed extremely high cumulative odds relative to Oromia at ANC4+ (OR=12.9, 95% CI 5.95–27.9; $p<0.001$) and Stage 2 (OR=13.9, 95% CI 7.89–24.5; $p<0.001$), with a smaller but still substantial complete-continuum OR of 3.06 (95% CI 1.78–5.24; $p<0.001$). Among women who had already reached ANC4+ and facility delivery, however, Addis Ababa did not differ from Oromia in timely postnatal care (OR=0.925, 95% CI 0.498–1.72; $p=0.806$). This indicates that the capital's very large cumulative advantage is concentrated in earlier pathway progression rather than a superior final conditional transition.

Several additional regions had significantly lower conditional odds of timely postnatal care than Oromia despite having reached ANC4+ and facility delivery: Tigray (OR=0.50, $p=0.012$), Benishangul-Gumuz (OR=0.441, $p=0.006$), Harari (OR=0.418, $p=0.004$), and Dire Dawa (OR=0.389, $p=0.003$). These contrasts reinforce the conclusion that postpartum continuity has a distinct geographic structure.

Figure 4. Adjusted regional odds ratios for cumulative and conditional maternal-care outcomes, Ethiopia EDHS 2024–25



Points are adjusted ORs; horizontal lines are 95% CIs. Open points denote regional cells with <10 unweighted events or non-events. Global design-based Wald tests for region are shown in each panel heading. The dashed vertical line denotes the Oromia reference (OR=1). Source: Ethiopia DHS 2024-25.

Discussion

This study provides a contemporary national assessment of maternal-care continuity in Ethiopia that integrates socioeconomic inequality, 14-region geography, and stage-specific inference. Four findings are central. First, national retention falls sharply across the cumulative pathway: only about one quarter of women complete ANC4+, facility delivery, and timely maternal postnatal care. Second, education and household wealth strongly stratify cumulative retention. Third, regional heterogeneity remains highly statistically evident after adjustment for these socioeconomic dimensions. Fourth, the relative pattern of socioeconomic and geographic association changes across transitions, most notably after facility delivery, where the wealth association with timely postnatal care is no longer statistically detectable while regional heterogeneity persists.

The national complete-continuum estimate of 26.1% is strikingly close to the pooled estimate of 25.5% reported in the 2022 systematic review and meta-analysis of Ethiopian continuum studies, although the component definitions, study periods, geographic coverage, and underlying populations differ and direct equivalence should not be assumed (Addisu et al., 2022). The persistence of low completion despite major gains in individual maternal-health services supports a shift in monitoring from isolated contacts toward retention across the pathway.

Our socioeconomic findings align with a broader Ethiopian literature showing higher maternal-health service use among women with more education and greater household resources. Wuneh et al. (2022) documented substantial wealth and education inequities in maternal and child health service utilization in rural Ethiopia. Tiruneh et al. (2022) found wealth and region to be associated with continuation across antepartum, intrapartum, and postpartum stages, with discontinuation especially important at the postpartum stage. Recent PMA Ethiopia analyses likewise report large economic, educational, residential, and subnational inequalities in ANC4+, skilled birth attendance, and PNC. This analysis adds to the literature by modeling the continuum cumulatively and asking whether the geographic pattern persists when education and wealth are modeled simultaneously.

The answer is clearly yes at the level of statistical association. The global region term remained significant at $p < 0.001$ for every cumulative outcome and every conditional transition. This finding is more informative than identifying a handful of region-versus-reference coefficients because it tests the 14-level regional factor jointly. It also protects against the temptation to define the geographic story around one unusually high or low region. The attenuation of regional F statistics after adjustment is equally informative: education and wealth explain part of the observed geographic pattern, but substantial heterogeneity remains.

What might this residual regional heterogeneity represent? Region can proxy many interacting conditions: distance and travel time, road networks, urban concentration, distribution and readiness of facilities, referral pathways, health-worker density and deployment, continuity of commodities and diagnostics, community health platforms, local administrative capacity, security and displacement, livelihood and mobility patterns, language, trust, and social expectations surrounding pregnancy and childbirth. Because these mechanisms were not all measured in the present models, the region coefficients should not be reified as causal effects. Rather, they identify geographic contexts in which the probability of progressing through care differs even among women with similar measured education and household wealth.

The conditional models sharpen that interpretation. A region may perform poorly in cumulative completion because few women enter adequate antenatal care, because women who obtain ANC do

not proceed to facility delivery, because women who deliver in facilities do not receive timely maternal PNC, or because several losses accumulate. These are not interchangeable programmatic problems. A policy response focused on maternity waiting homes or transport may be relevant to one transition; strengthening discharge protocols, postnatal checks before discharge, referral back to community health workers, or early home follow-up may be more relevant to another.

Somali provides the clearest example of why pathway decomposition matters. Its cumulative results are extremely low, but conditional retention from ANC4+ to facility delivery is high among the small group of women who reach ANC4+. The major descriptive loss occurs before ANC4+, and the inferential model then identifies a second major disadvantage in timely PNC after facility delivery. This pattern argues against describing Somali simply as a uniformly low-utilization region. Instead, it suggests at least two distinct points of disconnection: entry into adequate antenatal care and retention after childbirth. The apparent strength of facility delivery among women who have already reached ANC4+ may reflect selection, service-seeking trajectories, or other contextual factors and should not be interpreted as a causal regional advantage.

Addis Ababa represents almost the mirror image. Nearly all women reach ANC4+ and facility delivery, generating very large adjusted odds ratios relative to Oromia at the first two cumulative stages. Yet the Addis–Oromia contrast disappears for timely PNC once women have already achieved ANC4+ and facility delivery. In absolute terms, Addis Ababa loses almost 30 percentage points between Stage 2 and Stage 3. This is an important reminder that high-performing health systems can still have substantial continuity gaps after childbirth. Near-universal facility delivery does not guarantee completion of the early postnatal component.

The final conditional transition may be the paper's most policy-relevant finding. Wealth is strongly associated with reaching ANC4+ and with facility delivery among women reaching ANC4+, but it is no longer statistically associated with timely PNC after both preceding stages are achieved. Education remains associated, although with a smaller OR, and region remains globally significant. One interpretation is that household economic barriers dominate earlier access and progression, while the post-delivery transition may depend more heavily on service organization, provider practice, discharge processes, local follow-up systems, knowledge, communication, or other contextual conditions. This interpretation is plausible but not directly tested and should be framed as a hypothesis for further study rather than a demonstrated mechanism.

This stage-dependent pattern also aligns with a broader quality-of-care perspective. Universal health coverage is not achieved simply by bringing people into contact with services; effective coverage requires that health systems deliver competent, timely, respectful, and continuous care (Kruk et al., 2018). For maternal health, a woman who reaches a facility for childbirth but leaves without appropriate maternal postnatal assessment, counselling, or linkage to follow-up represents a continuity failure even if facility-delivery coverage is high. WHO postnatal guidance emphasizes routine, person-centred care for women and newborns during this period (WHO, 2022).

The findings therefore support a 'place matters' approach that is more specific than generic decentralization. National targets remain necessary, but regions should be monitored using stage-specific retention profiles. A region with low ANC4+ entry requires a different strategy from a region with high ANC4+ and facility delivery but poor postnatal retention. National dashboards that report only ANC, facility delivery, and PNC as independent indicators can obscure these distinctions. A continuum dashboard could report cumulative coverage, absolute transition losses, and conditional retention side by side.

Three heatmaps are especially suitable for policy translation. The first should show cumulative regional coverage across Stages 1–3. The second should show absolute percentage-point losses at each transition, identifying where the largest share of the original cohort is lost. The third should show conditional retention, identifying how successfully women who reached one stage progress to the next. Together, these visualizations distinguish burden from process: absolute loss identifies the population-level contribution to non-completion, while conditional retention identifies the efficiency of progression among women already connected to care.

The study also has implications for equity monitoring. The persistence of education and wealth associations after regional adjustment indicates that geographic targeting alone would be insufficient. Conversely, the persistence of regional heterogeneity after socioeconomic adjustment indicates that a purely household-level equity strategy would also be incomplete. Maternal-health policy must therefore be both socially and geographically differentiated. The appropriate unit of response may vary: national financing and workforce policy, regional planning, woreda-level implementation, facility-level quality improvement, and community-level linkage all potentially contribute to continuity.

Finally, the results suggest that continuum research should resist a single-outcome mindset. Complete-continuum attainment is valuable as a summary indicator, but it compresses multiple processes into one binary outcome. The combination of cumulative outcomes, conditional transitions, and global contextual tests produces a more interpretable account. It tells us not only who reaches the end, but where the pathway breaks and whether the structure of inequality changes after women have successfully crossed earlier barriers.

Policy and program implications

- First, maternal-health monitoring should add cumulative continuum indicators to existing independent coverage indicators. The key question should be not only whether ANC, facility delivery, and PNC occur somewhere in the population, but how many women remain continuously connected through all three.
- Second, regional planning should be based on attrition fingerprints. Somali's dominant entry deficit, Afar's large ANC-to-facility loss, and the large post-delivery losses in Addis Ababa and Dire Dawa represent different service-delivery problems and should not be addressed with a single national template.
- Third, socioeconomic equity remains fundamental. The very low complete-continuum coverage among women with no formal education and among the bottom 40% of households indicates that improvements in national averages can coexist with severe exclusion. Financial protection, geographic access, communication, respectful care, and service navigation should be evaluated specifically among these groups.
- Fourth, postnatal continuity deserves greater visibility. The final transition is where several regions lose a large proportion of women who have already reached facility delivery. Facility-based systems should treat timely maternal PNC as an expected continuation of childbirth care rather than as a separate service that requires women to re-enter the system.
- Fifth, the persistence of region after education and wealth adjustment should motivate measurement rather than speculation. Future analyses should test candidate mechanisms such as rurality, travel time, facility density and readiness, conflict/displacement exposure, health-worker

availability, quality of ANC, mode and place of delivery, discharge timing, and community follow-up. Spatial and multilevel methods may be particularly useful.

Strengths

- The analysis uses the most recent nationally representative EDHS and preserves the complex survey design.
- The continuum is strictly cumulative, preventing later-stage coverage from being interpreted independently of preceding care.
- National estimates were validated before subgroup and inferential extensions were permitted to proceed.
- Contemporary 14-region geography provides policy-relevant subnational differentiation without imposing historical regional reconstruction on a cross-sectional question.
- The analysis integrates descriptive equity gradients, regional coverage, absolute loss, conditional retention, survey-weighted regression, and design-based omnibus tests.
- Conditional-transition models identify where associations change along the pathway rather than relying solely on a final binary outcome.
- Sparse-cell audits explicitly identify regional coefficients that require cautious interpretation.

Limitations

- The study is observational and cross-sectional for the associations examined. Odds ratios and regional contrasts do not establish causality.
- Region is a broad contextual marker. Without direct measurement of health-system, geographic, social, environmental, or security-related pathways, residual regional heterogeneity cannot be attributed to any single mechanism.
- The use of ANC4+ reflects the analytic indicator and continuity framework but is less demanding than the current WHO recommendation of at least eight antenatal contacts. Results therefore should not be interpreted as measuring adherence to the current WHO ANC model.
- Maternal service histories are self-reported and may be affected by recall or classification error, although restriction to the most recent birth within two years reduces recall duration.
- Timely postnatal care is defined from DHS variables and timing conventions; it captures whether maternal PNC occurred within two days but does not measure the completeness, technical quality, respectful nature, or clinical content of that contact.
- Facility delivery is a location indicator and does not itself measure quality of intrapartum care. High facility-delivery retention can coexist with deficits in readiness, respectful care, referral, or postpartum follow-up.
- Education and wealth were deliberately simplified into binary contrasts. These contrasts improve interpretability and power but conceal gradients within educational levels and wealth quintiles.
- Odds ratios can appear large when outcomes are common and should not be interpreted as prevalence ratios. The manuscript therefore emphasizes absolute percentages and conditional retention alongside ORs.

- Some regional conditional models contain sparse events or non-events. Addis Ababa and Harari, for example, had very few non-facility deliveries among women reaching ANC4+, producing wide confidence intervals for corresponding ORs. Somali had only 10 unweighted Stage-3 events. The global region tests and descriptive estimates should therefore carry more interpretive weight than isolated extreme coefficients.
- The contemporary 14-region analysis is cross-sectional and cannot by itself distinguish temporal change from current geographic heterogeneity. Longitudinal regional trend analyses require explicit harmonization of historical administrative boundaries.
- Potential confounders beyond education and wealth were not included in the primary models because the scientific purpose was to test whether geographic heterogeneity persisted after two central socioeconomic dimensions, not to estimate a fully causal model. Future multivariable and multilevel analyses may incorporate residence, maternal age, parity, media exposure, autonomy, pregnancy intention, distance/access measures, and service-quality indicators.
- The analysis focuses on maternal continuity and does not incorporate newborn postnatal care or longer-term postpartum services. The complete continuum defined here should therefore not be equated with the entire maternal-newborn continuum of care.

Conclusion

Ethiopia's 2024–25 maternal-care continuum reveals a paradox of expanding service contact alongside substantial discontinuity. Just over half of women reached ANC4+, fewer than half remained through facility delivery, and only about one quarter completed the pathway through timely maternal postnatal care.

The inequality underlying this attrition is multidimensional. Education and household wealth strongly differentiate cumulative retention, and those associations persist after regional adjustment. At the same time, contemporary region remains associated with every cumulative stage and every conditional transition after accounting for education and wealth. Place therefore matters beyond what these two measured socioeconomic dimensions can explain.

The most important implication is that place does not matter in the same way everywhere or at every stage. Some regions lose women primarily before adequate antenatal contact; others lose women between antenatal care and facility delivery; still others retain women through childbirth but fail to sustain timely postnatal care. The disappearance of the wealth association at the final conditional transition, alongside persistent regional heterogeneity, further suggests that the architecture of inequality changes as women progress through care.

A maternal-health strategy built only around national averages will miss these pathway-specific failures. Ethiopia's next phase of maternal-health improvement should pair socioeconomic equity with geographically differentiated continuity strategies, monitor retention rather than isolated contacts alone, and make the transition from facility childbirth to timely postnatal care an explicit measure of health-system performance.

Declarations

Ethics approval and consent to participate: Secondary analysis of de-identified DHS data. Insert the exact DHS data-access and original survey ethical-approval language required by the target journal.

Consent for publication: Not applicable.

Availability of data and materials: The 2024–25 EDHS data are available through the authorized DHS/ESS data-access process subject to applicable conditions.

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References

- Addisu, D., Mekie, M., Melkie, A., Abie, H., Dagnaw, E., Bezie, M., Degu, A., Biru, S., & Chanie, E. S. (2022). Continuum of maternal healthcare services utilization and its associated factors in Ethiopia: A systematic review and meta-analysis. *Women's Health*, 18, 17455057221091732. <https://doi.org/10.1177/17455057221091732>
- Ahmed, R., Sultan, M., Abose, S., Assefa, B., Nuramo, A., Alemu, A., et al. (2022). Levels and associated factors of the maternal healthcare continuum in Hadiya zone, Southern Ethiopia: A multilevel analysis. *PLOS ONE*, 17(10), e0275752. <https://doi.org/10.1371/journal.pone.0275752>
- Chaka, E. E. (2023). Multilevel analysis of continuation of maternal healthcare services utilization and its associated factors in Ethiopia: A cross-sectional study. [Journal details to be verified against the final bibliographic record before submission]. <https://pubmed.ncbi.nlm.nih.gov/36962425/>
- Ethiopian Statistical Service (ESS) & ICF. (2026). Ethiopia Demographic and Health Survey 2024–25: Detail report. Addis Ababa, Ethiopia, and Rockville, Maryland, USA: ESS and ICF. <https://ess.gov.et/download/ethiopia-demographic-and-health-survey-edhs-2024-25-detail-report/>
- Federal Ministry of Health. (2020). Health Sector Transformation Plan II (HSTP II), 2020/21–2024/25. Addis Ababa, Ethiopia: Federal Ministry of Health. https://ict.moh.gov.et/en/elibrary/public_documents/a5d03f23-9afb-46d0-b823-7556c15ddee4
- Kerber, K. J., de Graft-Johnson, J. E., Bhutta, Z. A., Okong, P., Starrs, A., & Lawn, J. E. (2007). Continuum of care for maternal, newborn, and child health: From slogan to service delivery. *The Lancet*, 370(9595), 1358–1369. [https://doi.org/10.1016/S0140-6736\(07\)61578-5](https://doi.org/10.1016/S0140-6736(07)61578-5)
- Kruk, M. E., Gage, A. D., Arsenault, C., Jordan, K., Leslie, H. H., Roder-DeWan, S., Adeyi, O., Barker, P., Daelmans, B., Doubova, S. V., English, M., García-Elorrio, E., Guanais, F., Gureje, O., Hirschhorn, L. R., Jiang, L., Kelley, E., Lemango, E. T., Liljestrand, J., Malata, A., Marchant, T., Matsoso, M. P., Meara, J. G., Mohanan, M., Ndiaye, Y., Norheim, O. F., Reddy, K. S., Rowe, A. K., Salomon, J. A., Thapa, G., Twum-Danso, N. A. Y., & Pate, M. (2018). High-quality health

- systems in the Sustainable Development Goals era: Time for a revolution. *The Lancet Global Health*, 6(11), e1196–e1252. [https://doi.org/10.1016/S2214-109X\(18\)30386-3](https://doi.org/10.1016/S2214-109X(18)30386-3)
- Kruk, M. E., Gage, A. D., Joseph, N. T., Danaei, G., García-Saisó, S., & Salomon, J. A. (2018). Mortality due to low-quality health systems in the universal health coverage era: A systematic analysis of amenable deaths in 137 countries. *The Lancet*, 392(10160), 2203–2212. [https://doi.org/10.1016/S0140-6736\(18\)31668-4](https://doi.org/10.1016/S0140-6736(18)31668-4)
- Tiruneh, G. T., et al. (2022). Predictors of maternal and newborn health service utilization across the continuum of care in Ethiopia: A multilevel analysis. *PLOS ONE*, 17, e0264612. <https://doi.org/10.1371/journal.pone.0264612>
- World Health Organization. (2016). WHO recommendations on antenatal care for a positive pregnancy experience. Geneva: World Health Organization. <https://www.who.int/publications/i/item/9789241549912>
- World Health Organization. (2018). WHO recommendations: Intrapartum care for a positive childbirth experience. Geneva: World Health Organization. <https://www.who.int/publications/i/item/9789241550215>
- World Health Organization. (2022). WHO recommendations on maternal and newborn care for a positive postnatal experience. Geneva: World Health Organization. <https://www.who.int/publications/i/item/9789240045989>
- Wuneh, A. D., Bezabih, A. M., Okwaraji, Y. B., Persson, L. Å., & Medhanyie, A. A. (2022). Wealth and education inequities in maternal and child health services utilization in rural Ethiopia. *International Journal of Environmental Research and Public Health*, 19(9), 5421. <https://doi.org/10.3390/ijerph19095421>
- [PMA Ethiopia inequality study]. (2025). Inequalities in utilization of maternal health services in Ethiopia: Evidence from the PMA Ethiopia longitudinal survey. [Complete author and journal details to be verified before submission]. <https://pubmed.ncbi.nlm.nih.gov/39839399/>