

Beyond Population Composition: Explaining Ethiopia's Quarter-Century Change in Modern Contraceptive Use, 2000–2024–25

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Abstract

Background: Ethiopia experienced one of sub-Saharan Africa's most pronounced increases in modern contraceptive use during the first part of the twenty-first century, followed by little national change after 2016. Conventional trend and regression analyses do not quantify how much temporal change reflects shifts in women's characteristics versus changes in contraceptive behavior, context, and other unmeasured conditions.

Methods: Individual-record data from the 2000, 2005, 2011, 2016, and 2024–25 Ethiopia Demographic and Health Surveys (EDHS) were harmonized; decomposition contrasts were 2000–2016, 2016–2024–25, and 2000–2024–25. The analytic universe was currently married women aged 15–49. We specified four determinant domains: background characteristics (age, education, residence, historical region, household wealth), fertility experience (number of living children), access to information/services (exposure to family-planning messages through radio, television, or newspapers/magazines), and reproductive goals (fertility preference). Survey-weighted propensity reweighting standardized the earlier survey to the later determinant distribution, and Shapley values allocated the composition component across domains.

Results: Modern contraceptive prevalence increased from 6.30% in 2000 to 35.25% in 2016 (+28.95 percentage points [pp]) and was 34.46% in 2024–25 (–0.79 pp from 2016). During 2000–2016, measured composition accounted for 4.12 pp and the behavioral/structural residual for 24.83 pp. During 2016–2024–25, composition favored an increase (+0.53 pp), but the residual was negative (–1.32 pp). Across 2000–2024–25, the primary estimates were 5.62 pp for composition and 22.54 pp for the residual. Background characteristics were the largest positive compositional contributor (+5.03 pp), followed by information exposure (+1.84 pp); reproductive goals contributed –1.44 pp. The primary full-period effective-sample-size (ESS) ratio was 0.214; stronger trimming raised it to 0.308–0.385 while yielding composition estimates of 5.04–4.68 pp.

Conclusions: Measured shifts in population composition explain only a minority of Ethiopia's contraceptive expansion. Most of the long-run increase remains associated with changes in behavior, context, relationships between measured characteristics and use, and unmeasured structural conditions. The post-2016 plateau likewise reflects offsetting forces rather than an absence of favorable compositional change.

Keywords: Ethiopia; modern contraception; family planning; Demographic and Health Survey; decomposition; Shapley value; reweighting; contraceptive transition

Introduction

Access to contraception enables individuals and couples to determine whether and when to have children and supports reproductive autonomy, prevention of unintended pregnancy, and broader maternal and child health goals (World Health Organization [WHO], 2025). Ethiopia's modern contraceptive transition has been substantial. Among currently married women, national EDHS estimates rose from approximately 6% in 2000 to 35% in 2016 and remained near that level in 2024–25 (Central Statistical Authority [CSA] & ORC Macro, 2001; CSA & ICF, 2016; Ethiopian Statistical Service [ESS] & ICF,

2026). The long-run increase occurred alongside major changes in education, urbanization, wealth, fertility, service access, and reproductive preferences, but it also retained pronounced regional and socioeconomic inequalities (CSA & ICF, 2016; Nimani et al., 2023).

Previous Ethiopian studies have identified age, education, household wealth, residence, number of living children, fertility preferences, media exposure, and other individual and community characteristics as correlates of modern contraceptive use (Meselu et al., 2022; Nimani et al., 2023; Tiruneh et al., 2016). Other evidence points to mechanisms that are not reducible to population composition. Ethiopia's Health Extension Program expanded community-level access to basic services and has been associated with contraceptive uptake (Yitayal et al., 2014). Facility quality, counseling quality, information on side effects and alternatives, and the surrounding service environment can also shape contraceptive behavior (Ejigu et al., 2022; Fruhauf et al., 2018; Hrusa et al., 2020; Tessema et al., 2017). Social influences, stigma, and women's decision-making autonomy further demonstrate that women with similar demographic characteristics may experience very different conditions for acting on reproductive intentions (Jain et al., 2019; Mare et al., 2022).

A smaller body of literature has asked a different question: what explains change over time? Worku et al. (2015) decomposed the 2000–2011 rise among young married women aged 15–24 and attributed 34% of the increase to differences in women's characteristics and about two-thirds to differences in coefficients. Ethiopian studies of declining unmet need have similarly found that coefficient-related change can dominate compositional change (Alemu et al., 2024; Tareke et al., 2022). These studies establish the value of decomposition, but none addresses the full population of currently married women across the 2000–2024–25 interval or separates Ethiopia's rapid pre-2016 expansion from the subsequent plateau.

A standard multivariable regression can identify independent correlates of contraceptive use, but it does not quantify the relative contribution of changing determinant distributions to the recorded temporal change. Sequentially entering covariate blocks also makes attribution depend on an arbitrary ordering. We therefore used survey-weighted reweighting standardization and an order-independent Shapley allocation. The Shapley framework assigns each domain its average marginal contribution across possible orderings and guarantees exact allocation of the total composition component (Shorrocks, 2013). Reweighting-based decomposition has also been applied in epidemiology to distinguish differences associated with observed risk-factor distributions from residual differences not removed by standardization (Jackson et al., 2015).

Our objectives were to quantify the composition and behavioral/structural components of change in modern contraceptive prevalence for three periods—2000–2016, 2016–2024–25, and 2000–2024–25—and to allocate the composition component across four policy-relevant determinant domains: background characteristics, fertility experience, access to information/services, and reproductive goals. We also assessed whether the full-period estimates were robust to limited covariate overlap.

Methods

Data sources and analytic population

We used women's Individual Recode files from the 2000, 2005, 2011, 2016, and 2024–25 EDHS. The EDHS series uses nationally representative, stratified multistage household samples and standardized questionnaires; ESS implemented the 2024–25 survey with technical assistance from ICF (ESS & ICF, 2026). The principal decomposition contrasts were 2000 versus 2016, 2016 versus 2024–25, and 2000 versus 2024–25. We retained the 2005 and 2011 surveys in the harmonization and validation workflow to test longitudinal construct continuity. The analytic universe was currently married women aged 15–49 (DHS v502 = 1).

Outcome and determinant domains

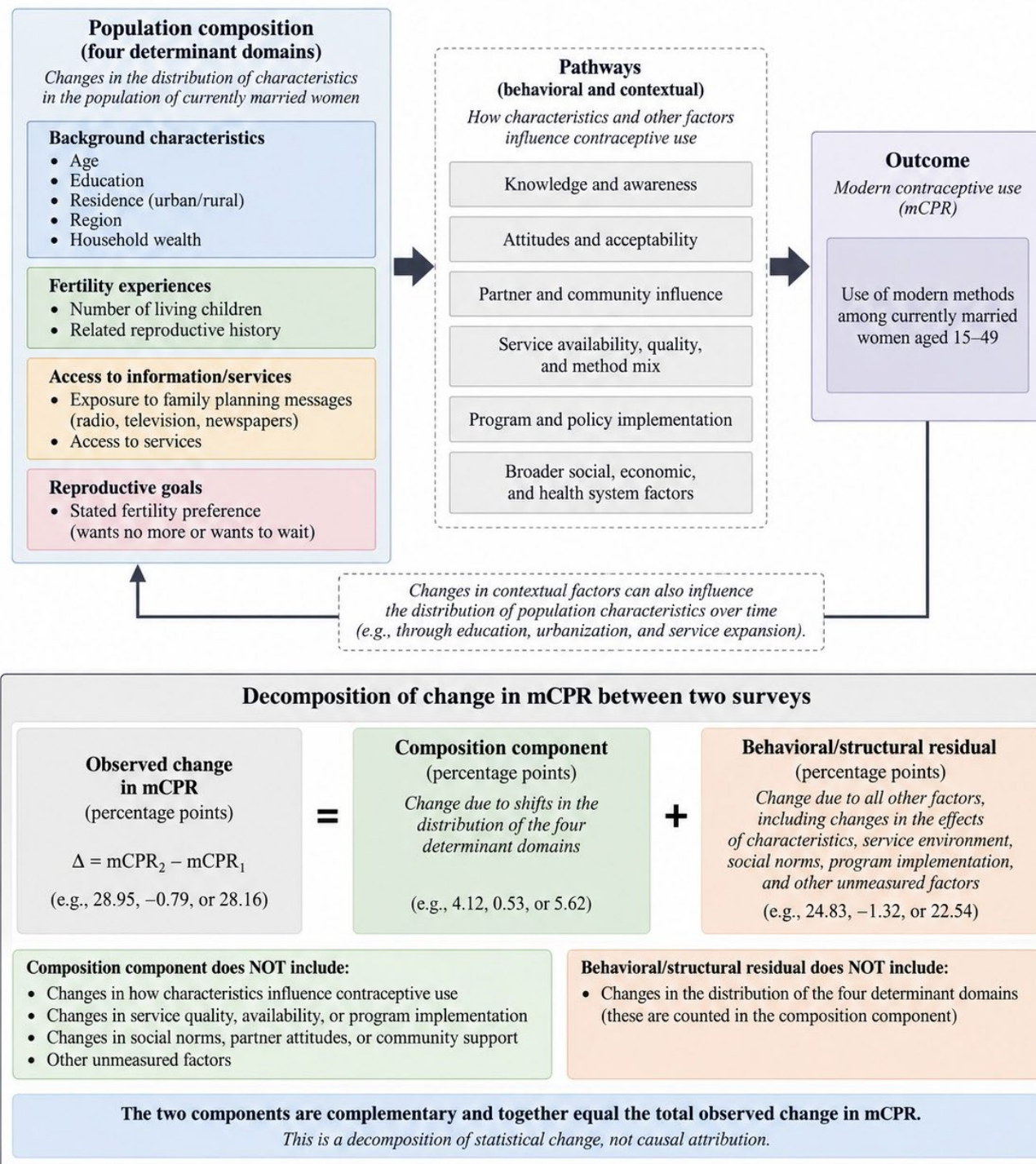
The outcome was current use of a modern contraceptive method, harmonized from DHS variable v313. We specified four determinant domains a priori. Background characteristics comprised age group, educational attainment, urban/rural residence, historical region, and household wealth. Fertility experience was represented by number of living children. Access to information/services was represented by exposure to family-planning messages through radio, television, or newspaper/magazine. This harmonized measure intentionally captures three legacy mass-media channels consistently available across survey rounds; it does not represent the broader 2024–25 information environment. We represented reproductive goals through stated fertility preference.

Administrative boundaries changed substantially over the study period. For longitudinal comparability, we mapped Central Ethiopia, Sidama, South Ethiopia, and South West Ethiopia in 2024–25 to the historical SNNPR, and standardized spelling variants in regional labels.

Conceptual framework

Figure 1 distinguishes two sources of survey-to-survey change. The composition component represents change associated with shifts in the measured distributions of the four determinant domains. The behavioral/structural residual is the remaining difference after standardization. It includes changes in how measured characteristics relate to contraceptive use and influences not included in the harmonized composition model, such as service availability and quality, method mix, counseling, partner and community influences, program implementation, and other unmeasured contextual factors. The two components are mathematical complements and sum exactly to observed change, but neither should be interpreted as a causal effect.

Figure 1. Conceptual framework for decomposing change in modern contraceptive use in Ethiopia, 2000–2024–25.



Observed change in mCPR is decomposed into a composition component attributable to shifts in the measured determinant distributions and a behavioral/structural residual representing the remaining statistical change. The decomposition is descriptive/statistical, not causal.

Procedural validation and forensic audit

A staged certification process preceded the final analysis. First, candidate survey files were screened for the expected Individual Recode structure. This identified a stale 2016 IR file in the 2024–25 directory; the certified 2024–25 file was ETIR8AFL.dta (21,395 women; 6,648 variables), with a distinct file hash and a reproduced contemporary national mCPR. Second, the 2000 wealth index, stored separately from the IR file, was merged after testing alternative respondent and household keys; the selected merge achieved complete matching.

Third, national mCPR was reconstructed within the currently married universe. Estimates were 6.33% in 2000, 13.91% in 2005, 27.34% in 2011, 35.25% in 2016, and 34.46% in 2024–25. The 2011 reconstruction differed from a retained 26.6% benchmark. A forensic audit of v313 found an internally coherent weighted distribution—27.34% modern, 1.22% traditional, 0.06% folkloric, and 71.39% no method—and alternative modern-method definitions did not alter the estimate. The reproducible IR estimate was therefore retained rather than widening the validation tolerance.

Fourth, marital-universe, region, missingness, and domain-eligibility audits were completed for every contrast. A broader $v502 \in \{1,2\}$ universe was explicitly tested and rejected because it moved reconstructed mCPR farther from the currently married benchmarks in every survey. Complete-case retention was 99.90% by survey weight in 2000 and 100% in 2016 and 2024–25. Fifth, raw labels and coding for radio, television, and newspaper/magazine family-planning exposure were compared across all five surveys and judged substantively comparable.

Decomposition and Shapley allocation

For each contrast, survey weights were rescaled within period to have mean 1 for propensity-model estimation. A weighted binomial model predicted membership in the later survey from the determinant domains. For women in the earlier survey, predicted probabilities were converted to stabilized odds weights and multiplied by the original survey weights. In the primary specification, stabilized odds weights were truncated at the 1st and 99th percentiles.

Let P_0 denote observed early-period mCPR, P_1 observed later-period mCPR, and P_0^* the counterfactual early-period prevalence after reweighting to the later determinant distribution. Observed change was $P_1 - P_0$; the composition component was $P_0^* - P_0$; and the behavioral/structural residual was $P_1 - P_0^*$. By construction, composition plus residual equals observed change. For the four-domain allocation, counterfactual prevalence was estimated for every subset of domains, and Shapley values were obtained by averaging each domain's marginal contribution across all possible subset/order combinations (Shorrocks, 2013).

Overlap diagnostics, sensitivity analysis, and quality assurance

Effective sample size (ESS) after reweighting was compared with ESS under the original early-period survey weights. A full-reweight ESS ratio of at least 0.25 was prespecified as the overlap criterion. The 2000–2016 and 2016–2024–25 contrasts passed; the primary 2000–2024–25 model did not. Targeted full-period sensitivity analyses therefore retained all covariates while increasing weight truncation to the 2.5th/97.5th and 5th/95th percentiles. Additional diagnostic models excluded historical region, excluded wealth, or limited the background block to age, education, and residence.

Quality assurance required exact reproduction of the primary full-period result within the sensitivity engine, Shapley-to-composition additivity, total decomposition additivity, and automated warning classification. All 135 captured model warnings were the expected non-integer-success warning generated by continuous survey weights in weighted binomial models; no unexpected warning class was detected.

Results

Modern contraceptive prevalence in the analytic samples increased from 6.30% in 2000 to 35.25% in 2016 and was 34.46% in 2024–25. The rapid expansion phase therefore produced a 28.95-pp increase, the post-2016 phase a -0.79 -pp change, and the full quarter-century transition a 28.16-pp increase (Table 1).

Table 1. Decomposition of change in modern contraceptive prevalence among currently married women aged 15–49, Ethiopia

Survey comparison	Observed change in mCPR (pp)	Composition (pp)	Behavioral/structural residual (pp)	ESS ratio
2000–2016	28.95	4.12	24.83	0.549
2016–2024–25	-0.79	0.53	-1.32	0.450
2000–2024–25	28.16	5.62	22.54	0.214

Note. pp = percentage points; ESS = effective sample size. The 0.25 ESS-ratio criterion was prespecified for the full-reweighting overlap diagnostic.

Rapid expansion, 2000–2016

Reweighting the 2000 population to the 2016 distribution of all four determinant domains produced a counterfactual mCPR of 10.42%. The composition component was 4.12 pp, and the behavioral/structural residual was 24.83 pp. Measured composition therefore accounted for approximately 14.2% of the observed increase, and the residual for 85.8%. Background characteristics made the largest compositional contribution (+2.33 pp; 8.05% of observed change), followed by information exposure (+1.18 pp; 4.09%), reproductive goals (+0.38 pp; 1.32%), and fertility experience (+0.22 pp; 0.75%). The full-reweight ESS ratio was 0.549.

Post-2016 plateau, 2016–2024–25

The near-zero national change concealed opposing contributions. Background composition (+1.52 pp), fertility experience (+0.51 pp), and information exposure (+0.44 pp) each favored higher mCPR, whereas reproductive goals contributed -1.94 pp. The net composition component was +0.53 pp. The behavioral/structural residual was -1.32 pp, yielding the observed -0.79 pp change. Because the absolute observed change was below 2 pp, percentage-of-change contributions were suppressed as unstable. The ESS ratio was 0.450.

Full transition, 2000–2024–25

The all-domain counterfactual prevalence was 11.92%, compared with 6.30% observed in 2000 and 34.46% in 2024–25. The primary composition component was 5.62 pp, and the behavioral/structural residual was 22.54 pp. Background characteristics contributed +5.03 pp (17.86% of observed change), information/services exposure +1.84 pp (6.54%), fertility experience +0.18 pp (0.65%), and reproductive goals –1.44 pp (–5.10%). The positive domain contributions therefore exceeded the net composition component because the reproductive-goal distribution partially offset them.

The primary full-period ESS ratio was 0.214, below the prespecified threshold. With 2.5th/97.5th percentile trimming, ESS improved to 0.308 and the composition estimate was 5.04 pp; with 5th/95th percentile trimming, ESS improved to 0.385 and composition was 4.68 pp. Both retained the full substantive covariate specification and left a residual of approximately 23.1–23.5 pp. Excluding region did not resolve overlap (ESS 0.226; composition 5.92 pp), whereas excluding wealth (ESS 0.274; composition 8.11 pp) and using the core background block (ESS 0.292; composition 8.80 pp) passed the ESS criterion but materially changed the definition of the background domain. The signs of all four domain contributions were stable across sensitivity models.

Discussion

The central finding is that Ethiopia's contraceptive transition cannot be understood primarily as a consequence of changing population composition. During the 2000–2016 expansion, only about 4.1 pp of the nearly 29-pp increase was associated with measured changes in women's background characteristics, fertility experience, legacy information exposure, and reproductive goals. The much larger residual indicates that women with a given configuration of measured characteristics were substantially more likely to use modern contraception in 2016 than comparable women were in 2000, or that other determinants not included in the harmonized model changed substantially.

This finding is directionally consistent with earlier Ethiopian decomposition studies, while extending them in population, period, and method. Among married women aged 15–24, Worku et al. (2015) attributed 34% of the 2000–2011 increase to compositional differences and approximately two-thirds to coefficient differences. Analyses of unmet need likewise found coefficient-related change responsible for most of the decline between earlier EDHS rounds (Alemu et al., 2024; Tareke et al., 2022). Our analysis extends the evidence through 2024–25, includes all currently married women aged 15–49, and uses an order-independent four-domain Shapley allocation rather than relying on a single coefficient/composition split.

The post-2016 result may be the most policy-relevant. Ethiopia's national mCPR plateau did not occur because every favorable determinant stopped improving. Background characteristics, fertility experience, and legacy information exposure collectively pushed the standardized counterfactual upward. These gains were offset by a negative reproductive-goal contribution and a larger negative behavioral/structural residual. Aggregate stagnation therefore masks opposing processes. This interpretation complements evidence that contraceptive use and unmet need remain strongly differentiated by residence, wealth, region, fertility preferences, and exposure to information (Alemu et al., 2024; Meselu et al., 2022; Nimani et al., 2023).

The residual should not be labeled a program effect, but Ethiopia's service history identifies plausible mechanisms for further investigation. The Health Extension Program brought primary services closer to rural communities and has been associated with greater contraceptive utilization (Yitayal et al., 2014). Facility and counseling studies show that contraceptive behavior can depend on service quality,

information provision, provider practices, facility type, and the surrounding service environment (Ejigu et al., 2022; Fruhauf et al., 2018; Hrusa et al., 2020; Tessema et al., 2017). Social stigma and women's decision-making autonomy also affect whether reproductive intentions translate into use (Jain et al., 2019; Mare et al., 2022). Demographic composition alone does not adequately capture any of these mechanisms.

The full-period domain allocation adds further specificity. Background characteristics were the dominant positive compositional contributor, consistent with Ethiopia's substantial changes in education, residence, wealth, and regional population structure. Information exposure was also positive but modest. Fertility experience contributed little to the full-period change. Reproductive goals made a negative net contribution and were the strongest negative compositional force after 2016. This is not a causal statement about fertility preferences. It means that the observed redistribution of the harmonized fertility-preference categories, evaluated under the decomposition model, moved the standardized counterfactual in the opposite direction.

The sensitivity analysis strengthens the main inference while appropriately limiting precision. The primary full-period model had insufficient overlap, but stronger trimming restored the prespecified ESS criterion without dropping any substantive covariates and yielded composition estimates of 4.68–5.04 pp rather than 5.62 pp. Thus, under the most defensible full-specification sensitivity analyses, roughly 23 pp of the 28.16-pp quarter-century increase remained outside measured compositional change. The exact partition should not be overinterpreted, but the qualitative conclusion is stable.

These findings are directly relevant to Ethiopia's current family-planning agenda. National FP2030 commitments emphasize financing, contraceptive commodity security, adolescent- and youth-responsive services, and access to quality, safe family-planning information and services (Family Planning 2030, 2021). The decomposition suggests why such system-level investments remain necessary even when education, wealth, urbanization, or other background characteristics improve: population composition creates opportunity, but services, norms, information quality, method availability, and the broader enabling environment determine whether that opportunity is translated into voluntary contraceptive use. This interpretation also aligns with WHO's rights-based framing of contraceptive access, informed choice, and the removal of service and social barriers (WHO, 2025).

Limitations

This study has several limitations. First, the decomposition is statistical and noncausal. The behavioral/structural residual cannot be assigned to a specific program, policy, social norm, or service intervention. Second, only variables that could be harmonized across a quarter century were included. The access domain is restricted to three legacy mass-media channels and does not capture the broader 2024–25 information environment, including mobile phones, social media, community events, posters, and other channels. Third, method availability, stockouts, distance, service quality, counseling content, partner dynamics, provider behavior, and detailed program exposure were not consistently measured across all rounds and therefore enter, if at all, through the residual.

Fourth, administrative boundaries changed over time; historical SNNPR was reconstructed from successor southern regions to preserve longitudinal comparability. Fifth, the 2011 IR reconstruction yielded mCPR of 27.34%, modestly above the retained 26.6% benchmark. A forensic audit found no

alternative v313 coding that reproduced 26.6%, so the internally reproducible estimate was retained transparently. Sixth, common support was limited for the primary 2000–2024–25 full-background reweighting. Stronger trimming improved ESS and preserved the principal conclusion, but the exact full-period composition estimate is better interpreted as a sensitivity-supported range than as a single precise quantity. Finally, repeated cross-sectional surveys observe different women at each round; temporal decomposition does not represent within-woman change.

Conclusion

Ethiopia's modern contraceptive prevalence among currently married women increased by approximately 28 percentage points between 2000 and 2024–25, but measured shifts in population composition explain only a minority of that transition. The rapid pre-2016 expansion was dominated by a behavioral/structural residual, and the post-2016 plateau reflected offsetting positive and negative forces rather than the disappearance of favorable compositional change. Continued socioeconomic and demographic progress is therefore unlikely, by itself, to guarantee renewed growth in voluntary contraceptive use. Sustained gains require attention to the mechanisms that translate women's circumstances and reproductive goals into informed, voluntary use: commodity security, method choice, service quality, counseling, continuity of access, geographic equity, supportive social conditions, and a responsive health system.

Declaration of Generative AI and AI-Assisted Technologies in the Writing Process. During the preparation of this manuscript, the author used OpenAI to assist with analytical planning, manuscript organization, language refinement, methodological exposition, and presentation of the study findings.

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