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Human Resources for Health Flooding Strategy on Quality of Antenatal and Intrapartum Care Services in Ethiopia: A Quasi-Experimental Pre–Post Study

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ABSTRACT

Background: Ethiopia has implemented a Human Resources for Health (HRH) flooding strategy since 2011 to rapidly expand the availability of health professionals nationwide. Although this approach is expected to strengthen the healthcare workforce, its effects on healthcare quality and service delivery outcomes have not been comprehensively evaluated.

Objective: This study assessed the association between the HRH flooding strategy and maternal healthcare quality, with a focus on antenatal and intrapartum care, to inform strategies for optimizing the effectiveness of workforce investment.

Methods: A quasi-experimental pre-post design with propensity score matching was employed to evaluate changes in care quality following implementation of the HRH flooding strategy. Data were pooled from two rounds of the Ethiopian Demographic and Health Survey (EDHS), using the 2011 EDHS as the pre-intervention control group and the 2016 EDHS as the post-intervention group. The primary outcomes were the quality of antenatal care (ANC) and intrapartum care provided.

Results: The quality of ANC was 27.1% (95% CI: 25.7–28.6) in the treatment group compared to 8.5% (95% CI: 7.5–9.6) in the control group. Similarly, the quality of intrapartum care was 44.0% (95% CI: 42.4–45.6) and 20.8% (95% CI: 19.3–22.5) in the treatment group and control group, respectively. The average treatment effect of the HRH flooding strategy was associated with a 13.5 percentage-point improvement in the quality of ANC and a 23.3 percentage-point improvement in the quality of intrapartum care. Using a 0.01 caliper, radius matching achieved a strong balance between treatment and control groups.

Conclusion: Implementing the HRH flooding strategy is positively associated with improvements in the quality of ANC and intrapartum care services in Ethiopia. However, these findings should be interpreted with caution, as unmeasured confounding factors, including concurrent health system programs, may have contributed to the observed effect.

Keywords: Human Resources for Health; Maternal Health Services; Quality of Health Care; Propensity Score Matching

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INTRODUCTION

Sustainable Development Goal 3 (SDG 3) aims to reduce the global maternal mortality ratio (MMR) to fewer than 70 per 100,000 live births by 2030, with a strong emphasis on improving maternal health and access to quality healthcare services (1). Despite global progress, Sub-Saharan Africa (SSA) continues to bear a disproportionate burden of maternal and newborn mortality, where the lifetime risk of maternal death remains as high as 1 in 36 women (2). Globally, an estimated 210 million pregnancies occur each year, and many adverse pregnancy outcomes can be prevented or mitigated through timely and appropriate antenatal care (ANC) (3, 4).

In 2016, the World Health Organization (WHO) issued updated, comprehensive ANC guidelines to safeguard the health of pregnant women and their fetuses (5). Although coverage of maternal and child health services expanded during the Millennium Development Goal (MDG) era, accumulating evidence indicates that improvements in service quality have lagged behind gains in access (6, 7).

Healthcare quality refers to the extent to which health services increase the likelihood of desired health outcomes for individuals and populations and is defined as a core component of universal health coverage (8). The National Academy of Medicine defines quality healthcare as timely, efficient, equitable, patient-centered, safe, and effective (9). Achieving meaningful reductions in maternal and perinatal morbidity and mortality in low-income countries, therefore, requires substantial investment not only in expanding access and utilization of maternity services but also in improving the quality of care delivered (10).

Both measuring the quality of maternal healthcare and identifying its determinants are essential for improving current and future health outcomes in low-income countries (11). While considerable attention has been paid to increasing access to healthcare during pregnancy, childbirth, and the postnatal period, far less emphasis has been placed on ensuring that all recommended evidence-based guidelines are consistently upheld during antenatal, intrapartum, and postnatal care (12). Ethiopia, in particular, must accelerate improvements in the quality of maternal healthcare to achieve the SDG targets of reducing maternal mortality to fewer than 70 per 100,000 live births and neonatal mortality to fewer than 12 per 1,000 live births by 2030 (7).

Strengthening human resources for health (HRH) is a critical component of achieving these targets and represents one of the six core building blocks of the WHO health systems framework (13). HRH plays a central role in health system performance and accounts for a substantial proportion of health sector expenditure. Recognizing this, Ethiopia has prioritized HRH development as a cornerstone of its health sector transformation agenda and has implemented several HRH initiatives through successive health sector development plans (14). Nonetheless, persistent challenges remain, including low workforce density, inequitable distribution, and inefficient utilization of available personnel (14-17). In response, the Ethiopian government, in collaboration with the United States Agency for International Development (USAID), launched the Strengthening Human Resources for Health program (2012–2018) to address critical HRH gaps (18, 19).

In 2010, the WHO and the Global Health Workforce Alliance (GHWA) recommended a "flooding strategy" to rapidly increase the health workforce, particularly in countries facing severe shortages. Ethiopia has been classified as experiencing a health workforce crisis, with only 0.3 physicians, nurses, and midwives per 10,000 population—far below the critical threshold of 23 per 10,000 (20).

To address this shortage and align with the WHO recommendation of at least 10 physicians per 100,000 population in low-income countries (21), the Ethiopian Ministries of Health and Education substantially expanded pre-service training capacity. This included establishing new medical schools and health professional training programs, increasing the number of medical schools from three to over 33, and producing more than 3,000 graduates annually. The first large cohort of graduates entered the workforce between 2011 and 2012 (22-25).

Despite this rapid expansion, many training institutions continue to face shortages of qualified faculty, and the health system experiences high physician turnover. The HRH flooding strategy was therefore designed not only to rapidly scale up the health workforce but also to address longstanding geographic inequities, particularly in underserved rural areas (26-28). To advance universal access to primary healthcare, HRH reforms were implemented in phases, beginning with community-level services delivered by health extension workers and gradually expanding to health centers and hospitals (27, 28).

However, critics argue that the flooding approach may prioritize rapid workforce expansion at the expense of other critical of HRH development, such as quality, retention, and performance management dimensions(20). Against this backdrop, the present study aims to assess the impact of the HRH flooding strategy on the quality of antenatal care and intrapartum care services in Ethiopia using a quasi-experimental design.

METHODS

Data source

This study used data from the 2011 and 2016 Ethiopian Demographic and Health Surveys (EDHS), which are nationally representative, population-based cross-sectional surveys conducted as part of a global program funded by the United States Agency for International Development (USAID). The surveys collected comprehensive demographic and health information from women of reproductive age and young children. A multistage stratified cluster sampling design was employed, whereby households were selected within enumeration areas (clusters) (29).

The analysis included a total of 6,228 weighted respondents for the assessment of antenatal care (ANC) quality and 6,058 weighted respondents for intrapartum care quality, all of whom had given birth within the three years preceding each survey. The women individual record files from the 2011 and 2016 EDHS were used. Access to the datasets was granted upon approval from DHS office, obtained through their official website (http://www.measuredhs.com).

Outcome variable

This study assessed two broad outcome variables: the quality of ANC and the quality of intrapartum care.

Quality of antenatal care (ANC): was measured using five essential service components: (1) blood pressure measurement, (2) provision of iron supplementation, (3) blood testing for infection and anemia, (4) urine testing for bacteriuria and proteinuria, and (5) counseling on pregnancy danger signs. These indicators have been widely used in previous studies as proxy measures of ANC quality (30, 31). Women who received all five components were classified as having received quality ANC (coded as "1"), whereas those missing one or more components were classified as not having received quality ANC (coded as "0").

Quality of intrapartum care: was assessed using three indicators: (1) delivery in a health facility, (2) attendance by a skilled birth attendant, and (3) initiation of breastfeeding within one hour of birth. These indicators have been commonly employed to measure intrapartum care quality in prior studies (32, 33). Respondents who received all three components were classified as having received quality intrapartum care (coded as "1"), while those missing any component were classified as not having received quality intrapartum care (coded as "0").

Treatment variable

The treatment variable was the survey year, used as a proxy for exposure to the Human Resources for Health (HRH) flooding strategy. Respondents from the 2011 EDHS, conducted before implementation of the HRH flooding strategy, were designated as the control group, whereas respondents from the 2016 EDHS, conducted after implementation, were classified as the treatment group. This variable was coded as "1" for the treatment group and "0" for the control group.

Several covariates known to influence the quality of maternal healthcare services were considered, including maternal age, place of residence, women's educational status, employment status, partner's employment status, wealth index, marital status, timing of the first ANC visit, number of ANC visits, birth order, and religion. Rao–Scott chi-square tests were conducted using the survey ("svy") command, with v023 specified as the stratification variable and v021 as the primary sampling unit. Covariates with P-values < 0.05 were retained for inclusion in the propensity score matching process.

Data analysis

Radius matching with a caliper of 0.01 was employed to estimate the association between the HRH flooding strategy and the quality of ANC and intrapartum care services. Propensity score matching (PSM) is a widely used quasi-experimental method for estimating causal effects when randomization is not feasible, as it reduces selection bias by balancing observable characteristics between treatment and control groups (34). Propensity scores were estimated using a logit model via the Stata pscore command. Matching was then performed using the psmatch2 command with radius matching and a 0.01 caliper. This approach enabled estimation of the Average Treatment Effect on the Treated (ATT), representing the effect of the HRH flooding strategy on service quality among respondents surveyed after its implementation. The Average Treatment Effect on the Untreated (ATU) was also estimated to predict the potential effect of the HRH flooding strategy on respondents in the 2011 EDHS had they been exposed to the intervention. Additionally, the Average Treatment Effect (ATE) for the overall population was calculated.

The common support assumption was assessed by visually inspecting histograms and kernel density plots of propensity scores for treatment and control groups to ensure sufficient overlap. Balance diagnostics were conducted using the pstest command, examining mean and median bias, standardized percentage bias, t-statistics, pseudo R^2, and likelihood ratio (LR) chi-square statistics before and after matching to evaluate the quality of the matching process.

Sensitivity analysis

A sensitivity analysis was conducted to assess the robustness of propensity score-matching estimates to potential bias from unobserved confounders. The Mantel–Haenszel test statistic was applied to evaluate the sensitivity of the estimated treatment effects, accounting for the binary nature of the outcome variables (35).

RESULTS

A total of 6,228 weighted respondents who had given birth within the three years preceding the survey were included in the analysis of the first outcome: quality of ANC. Of these, 2,519 respondents were in the control group and 3,709 in the treatment group. The proportion of women who received quality ANC was 27.17% (95% CI: 25.7–28.6) in the treatment group, compared with 8.54% (95% CI: 7.53–9.68) in the control group.

For the second outcome, quality of intrapartum care, 6,058 weighted respondents who had given birth in the past three years were included. The quality of intrapartum care services was 44.0% (95% CI: 42.4–45.6) among the treatment group, whereas only 20.8% (95% CI: 19.3–22.5) of respondents in the control group received quality intrapartum care **(Table 1)**.

Estimation of Propensity Score

Propensity scores were estimated using logistic regression based on selected covariates to balance baseline characteristics between the treatment and control groups. The matching process resulted in eight blocks, with a region of common support ranging from 0.24 to 0.84. The mean propensity score was 0.58 (standard deviation: 0.09), indicating adequate overlap between the two groups.

Impact of HRH on the quality of ANC and intrapartum care

Radius matching with a caliper of 0.01 was applied to estimate the impact of the HRH flooding strategy. In the unmatched sample, respondents in the treatment group had a 13.4 percentage-point higher likelihood of receiving quality ANC and a 23.1 percentage-point higher likelihood of receiving quality intrapartum care compared with those in the control group.

After matching, the estimated Average Treatment Effect on the Treated (ATT) indicated that exposure to the HRH flooding strategy was associated with a 13.5 percentage-point increase in the probability of receiving quality ANC (95% CI: 11.3–15.4). Similarly, the HRH flooding strategy was associated with a 23.3 percentage-point increase in the likelihood of receiving quality intrapartum care (95% CI: 21.4–25.3). These findings suggest that women surveyed after the implementation of the HRH flooding strategy had a significantly higher chances of receiving high-quality antenatal and intrapartum care services compared with those surveyed before the strategy was introduced.

Quality of matching

Common support

The assessment of the common support condition indicated that only a small number of observations fell outside the overlap region between the treatment and control groups. For the first outcome variable (quality of ANC), six observations (five untreated and one treated) were outside the common support region and were excluded from the analysis. For the second outcome variable (quality of intrapartum care), five observations (three untreated and two treated) were similarly excluded (**Table 2**). Visual inspection of the propensity score distributions demonstrated substantial overlap between the treatment and control groups (**Figures 1** and **2**), confirming that the common support assumption for propensity score matching was satisfied.

Table 1: Propensity score matching estimates of average treatment Effect

Variable	Sample	Treated	Control	Difference in Proportions	S. E	T-stat
Quality of ANC care	Unmatched	0.18819	0.0539	0.1342	0.0085	15.74
	ATT	0.18818	0.0528	0.1353	0.0081	16.57
	ATU	0.05292	0.1847	0.1308		
	ATE			0.1327		
Quality of intrapartum care	Unmatched	0.4404	0.2087	0.2316	0.0120	19.30
	ATT	0.4404	0.2065	0.2338	0.0122	19.09
	ATU	0.208	0.4571	0.2489	0.2489	
	ATE			0.2401		

Table 2: Common Support

Treatment assignment (ANC)	Off support	On support	Total
Untreated	1	2,596	2,597
Treated	5	3,656	3,661
Total	**6**	**6,252**	**6,258**
Intrapartum care			
Untreated	3	2,521	2,524
Treated	2	3,558	3,560
Total	**5**	**6,079**	**6,084**

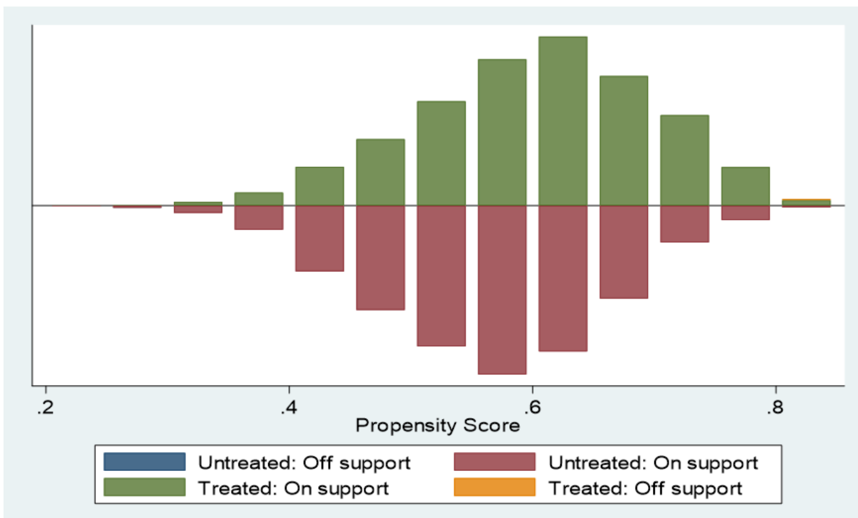

Figure 1: *Propensity score histogram by treatment status for ANC visit*

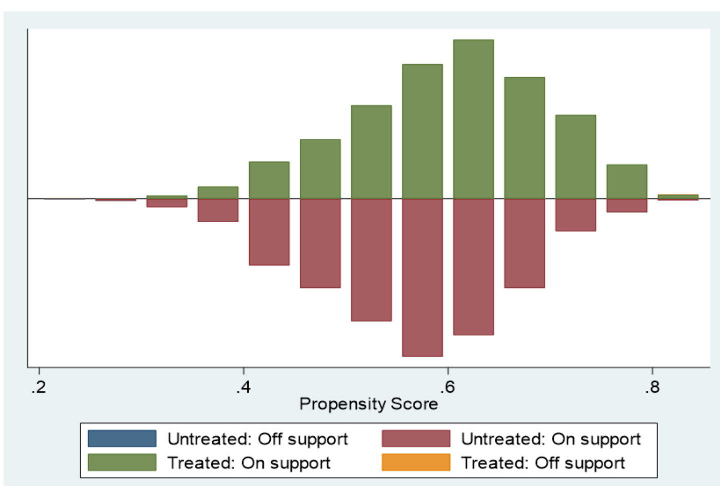

Figure 2: *Propensity score histogram by treatment status for intrapartum visit*

Balancing test

The matching procedure achieved a good balance across all covariates between the treatment and control groups. After matching, none of the covariates showed statistically significant differences between groups, with all p-values exceeding 0.05. Furthermore, the Pseudo R^2 decreased markedly from 0.029 before matching to 0.000 after matching, and the likelihood ratio (LR) chi-square statistic declined from 246.31 to 3.10, with a corresponding p-value of 0.989.

Substantial improvements were also observed in standardized balance measures. The mean bias was reduced from 9.1 to 1.0, and the median bias declined from 8.9 to 0.7. Similarly, the standardized mean difference (B) decreased from 40.8 to 4.1 (**Table 3**). Consistent with these findings, (**Figure 3)** illustrates that the standardized percentage bias across all covariates was close to zero following matching, further indicating a high-quality match.

Table 3: Balancing Test before and after matching

Variable	Sample	Mean		%bias	%bias reduction	T test	
		Treated	Control			t	p>|t|
Birth order	Unmatched	2.03	2.04	-1.3		-0.52	0.603
	Matched	2.03	2.03	-0.3	75.8	-0.14	0.891
Religion	Unmatched	2.07	2.01	6.8		2.65	0.008
	Matched	2.07	2.07	-0.4	94.2	-0.17	0.867
Timing of ANC	Unmatched	1.61	1.68	-13.3		-5.18	0.000
	Matched	1.611	1.61	-0.2	98.3	-0.10	0.924
Number of ANC visits	Unmatched	1.54	1.46	17.0		6.61	0.000
	Matched	1.54	1.55	-1.3	92.2	-0.57	0.569
Wealth Index	Unmatched	2.02	2.21	-20.4		-7.92	0.000
	Matched	2.02	2.03	-1.0	95.3	-0.40	0.687
Marital Status	Unmatched	1.05	1.07	-8.8		-3.46	0.001
	Matched	1.05	1.05	-0.4	95.5	-0.18	0.854
Maternal Employment Status	Unmatched	0.30	0.34	-8.9		-3.48	0.001
	Matched	0.30	0.32	-1.9	78.6	-0.83	0.408
Partners Education	Unmatched	0.94	0.92	2.5		0.95	0.342
	Matched	0.94	0.94	0.5	80.5	0.20	0.839
Maternal Age	Unmatched	1.87	1.88	-0.9		-0.34	0.732
	Matched	1.87	1.89	-2.5	-182.8	-1.06	0.290
Maternal Education	Unmatched	0.74	0.65	10.4		4.00	0.000
	Matched	0.74	0.75	-0.7	93.0	-0.30	0.764
Residence	Unmatched	1.71	1.67	9.4		3.69	0.000
	Matched	1.71	1.71	1.6	82.6	0.71	0.477
Sample	Ps R2	LR chi2	p>chi2	Mean bias	Med bias	B	R
Unmatched	0.029	246.31	0.000	9.1	8.9	40.8*	1.05
Matched	0.000	3.10	0.989	1.0	0.7	4.1	1.04

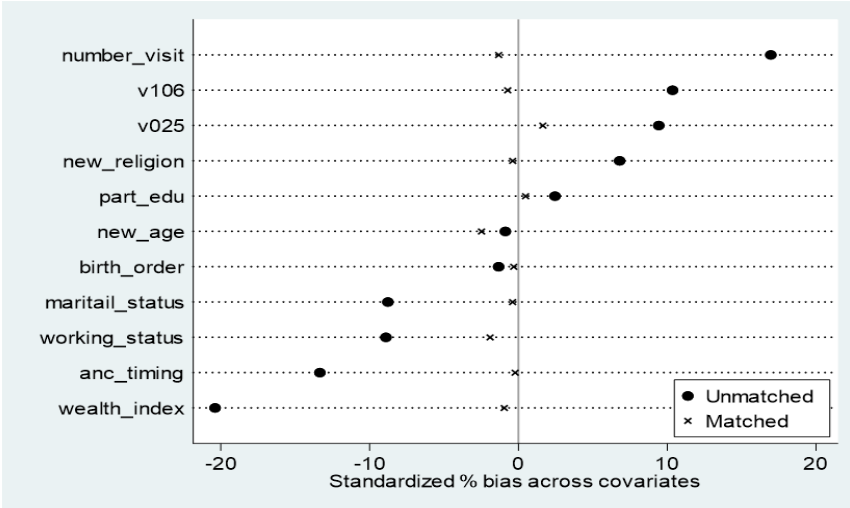

Figure 3: *Standardized % bias across covariates*

Sensitivity analysis

Sensitivity analysis suggested that the estimated treatment effects were robust to potential hidden bias for both outcome variables. The Mantel–Haenszel test statistics (Q_mh+ and Q_mh−) were similar for both outcomes when the sensitivity parameter (Γ) was equal to 1, indicating no hidden bias. As Γ increased to 2, the Mantel–Haenszel test became statistically significant, suggesting that the estimated effects would only be sensitive to relatively strong unobserved confounding **(Table 4 and 5).**

Table 4: Sensitivity analysis for the quality of the ANC service

Gamma	Q_mh+	Q_mh-	P_mh+	P_mh-
1	18.31	18.31	0	0
1.05	17.61	19.02	0	0
1.1	16.95	19.71	0	0
1.15	16.32	20.36	0	0
1.2	15.72	21.00	0	0
1.25	15.14	21.61	0	0
1.3	14.60	22.20	0	0
1.35	14.08	22.78	0	0
1.4	13.58	23.88	0	0
1.45	13.09	23.88	0	0
1.5	12.63	24.41	0	0
1.55	12.19	24.92	0	0
1.6	11.76	25.42	0	0
1.65	11.35	25.91	0	0
1.7	10.95	26.85	0	0
1.75	10.56	26.85	0	0
1.8	10.18	27.31	0	0
1.85	9.82	27.75	0	0
1.9	9.47	28.19	0	0
1.95	9.13	28.62	0	0
2	8.79	29.04	0	0

Gamma: odds of differential assignment due to unobserved factors
Q_mh+: Mantel-Haenszel statistic (assumption: overestimation of treatment effect)
Q_mh-: Mantel-Haenszel statistic (assumption: underestimation of treatment effect)
p_mh+: significance level (assumption: overestimation of treatment effect)
p_mh-: significance level (assumption: underestimation of treatment effect)
Gamma represents the odds of differential assignment to the intervention group due to an unobserved confounder. For example, **Gamma = 2** implies an unobserved factor could double the odds of being in the post-policy (2016) group.

Table 5: Sensitivity analysis for the quality of the Intrapartum care service

Gamma	Q_mh+	Q_mh-	P_mh+	P_mh-
1	18.71	18,71	0	0
1.05	17.85	19.58	0	0
1.1	17.03	20.41	0	0
1.15	16.24	21.21	0	0
1.2	15.50	21.98	0	0
1.25	14.79	22.72	0	0
1.3	14.10	23.43	0	0
1.35	13.45	24.12	0	0
1.4	12.82	24.79	0	0
1.45	12.21	25.43	0	0
1.5	11.63	26.06	0	0
1.55	11.06	26.67	0	0
1.6	10.52	27.26	0	0
1.65	9.99	27.83	0	0
1.7	9.48	28.39	0	0
1.75	8.99	28.94	0	0
1.8	8.51	29.47	0	0
1.85	8.04	29.99	<0.000	0
1.9	7.59	30.50	<0.000	0
1.95	7.14	30.99	<0.000	0
2	6.71	31.48	<0.000	0

Gamma: odds of differential assignment due to unobserved factors

Q_mh+: Mantel-Haenszel statistic (assumption: overestimation of treatment effect)

Q_mh-: Mantel-Haenszel statistic (assumption: underestimation of treatment effect)

p_mh+: significance level (assumption: overestimation of treatment effect)

p_mh-: significance level (assumption: underestimation of treatment effect)

Gamma represents the odds of differential assignment to the intervention group due to an unobserved confounder. For example, **Gamma = 2** implies an unobserved factor could double the odds of being in the post-policy (2016) group.

DISCUSSION

This study demonstrated a substantial improvement in the quality of maternal healthcare services following the implementation of Ethiopia's HRH flooding strategy. The quality of ANC was markedly higher in the treatment group (27.17%; 95% CI: 25.7–28.6) compared with the control group (8.54%; 95% CI: 7.53–9.68). Similarly, the quality of intrapartum care services was considerably higher among women in the treatment group (44.0%; 95% CI: 42.4–45.6) than among those in the control group (20.8%; 95% CI: 19.3 –22.5). These findings suggest that the HRH flooding strategy was positively associated with significant improvements in the quality of both antenatal and intrapartum care services in Ethiopia.

The propensity score–matched analysis further indicated that implementation of the HRH flooding strategy was associated with a 13.5 percentage-point increase in the quality of ANC and a 23.3 percentage-point increase in the quality of intrapartum care services. These improvements underscore the critical role of expanding the health workforce in addressing persistent gaps in maternal healthcare quality.

The observed improvements may be explained by reduced provider-to-patient ratios, greater availability of skilled health professionals, and enhanced access to care delivered by qualified practitioners, core objectives of the health workforce flooding strategy. This is particularly relevant in Ethiopia, where critical shortages of health personnel have historically constrained progress toward universal health coverage and improved maternal health outcomes (36).

Our findings are consistent with more recent evidence using 2019 data, which reported higher levels of quality ANC (36%) and comparable intrapartum care quality (43%) (33). This alignment suggests that the positive effects of the HRH flooding strategy may have persisted beyond the initial implementation period (2012–2018) (18). The observed improvements may also reflect complementary efforts under the HRH Project, including collaboration with the Higher Education Relevance and Quality Agency (HERQA) to strengthen accreditation, audit, and quality assurance mechanisms in health professional education. These initiatives aimed to enhance training standards, regulatory oversight, and institutional capacity, thereby contributing to improvements in service quality (19).

High-impact maternal health interventions, such as quality antenatal, intrapartum, and postnatal care, are essential for preventing adverse outcomes, including maternal and perinatal morbidity and mortality (37). However, ensuring access to high-quality care remains a major challenge in many low- and middle-income countries (LMICs), where health systems are often fragile and under-resourced (38-40). Ethiopia, in particular, must accelerate progress to meet the Sustainable Development Goals (SDGs), including reducing maternal mortality to fewer than 70 per 100,000 live births, achieving universal skilled birth attendance, and reducing neonatal mortality to fewer than 12 deaths per 1,000 live births by 2030 (41). This finding indicates that the HRH policy is playing a role in achieving the SDGs.

Strengths and Limitations

This study has several strengths. The use of nationally representative DHS data from two time points allowed for a robust comparison of maternal healthcare quality before and after implementation of the HRH flooding strategy. Employing propensity score matching strengthened causal inference by balancing observable characteristics between treatment and control groups, thereby approximating a randomized experimental design. Additionally, the large sample size enhances the generalizability of the findings to the Ethiopian population.

Nevertheless, some limitations should be acknowledged. While propensity score matching adjusts for observed confounders, it cannot account for unmeasured factors that may have influenced both exposure and outcomes. Concurrent health system reforms, local economic changes, or sociocultural shifts between 2011 and 2016 may have affected service quality independently of the HRH flooding strategy. As such, the findings should be interpreted with caution.

Policy Implication

The findings of this study indicate that the HRH flooding strategy was effective in improving the quality of antenatal and intrapartum care services in Ethiopia. Continued investment in the training, recruitment, equitable distribution, and retention of healthcare workers is therefore essential to sustain and further enhance gains in maternal healthcare quality.

Policymakers should consider integrating the HRH flooding strategy with complementary interventions, including strengthening health facility infrastructure, ensuring the availability of essential medical supplies, and addressing financial, geographic, and sociocultural barriers to care. Regular monitoring and evaluation of service quality following HRH interventions will also be critical for identifying implementation gaps and guiding evidence-based policy adjustments.

CONCLUSION

This study provides evidence that Ethiopia's HRH flooding strategy was positively associated with improvements in the quality of antenatal and intrapartum care services. Although unobserved factors and concurrent interventions may have influenced the results, the findings highlight the importance of strategic investments in the health workforce as a pathway to improving maternal health outcomes and advancing progress toward the Sustainable Development Goals.

Abbreviation

PSM: Propensity score matching
DHS: Demographic and Health Survey
HRH: Human Resource for Health
CI: Confidence Interval
ATT: Average Treatment Effect among Treated
ATU: Average Treatment effect on Untreated
ATE: Average Treatment effect on the whole population
ANC: Antenatal Care

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Declarations

Availability of data

The datasets used in this study are publicly available from the Measure DHS website: https://dhsprogram.com/data/available-datasets.cfm.

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The authors would like to sincerely acknowledge DHS for approving our acquisition, use, and study of the DHS dataset.

Author's contribution

A.K. conceptualized the study, conducted the literature review, contributed to methodology, performed the analysis, interpreted the results, and prepared the manuscript. E.D., M.J., M.G.T., G.T., and D.M.G. contributed to methodology, formal analysis, and interpretation of the data. K.A.D. contributed to conceptualization, methodology, analysis, and interpretation of the results and revised the manuscript. All authors have read and approved the final version of the manuscript.

Ethical review

This study used pre-existing, publicly available data from www.measuredhs.com, with all identifiers removed; therefore, ethical approval was not required. Permission to access and use the data was obtained from Measure DHS through an online request.

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Clinical trial number

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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