

Temporal Trends and Geographic Variation in Multiple Micronutrient Supplementation Implementation Performance in Ethiopia: A Routine Monitoring Data Analysis, 2023–2026

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Abstract *Maternal micronutrient deficiencies remain an important public health challenge in Ethiopia and contribute to adverse maternal and newborn outcomes. Ethiopia introduced Multiple Micronutrient Supplementation (MMS) through routine antenatal care services and progressively expanded implementation from 21 pilot woredas in 2023–2024 to 80 woredas nationwide by 2026. However, evidence on implementation performance during national scale-up remains limited. This study assessed temporal trends and geographic variation in MMS implementation performance using routine program monitoring data collected between January 2023 and June 2026. A longitudinal secondary analysis was conducted using woreda-month observations from the national MMS monitoring database. MMS achievement was defined as the percentage of pregnant women newly supplemented with MMS relative to the monthly target. Descriptive and non-parametric statistical analyses were applied. The final analytical dataset included 2,268 unique woreda-month observations of which 1,724 (76.0%) had available MMS achievement data. Mean MMS achievement was 100.2% (SD 56.3), while the median was 94.6% (IQR 70.5–120.4). Median achievement declined from 98.8% during 2023–2024 to 93.2% in 2025 and 89.9% in 2026. Existing woredas achieved higher median performance than Expansion woredas (96.4% vs. 85.3%; $p < 0.001$). Significant regional variation was observed, with median achievement ranging from 64.1% in Somali to 102.0% in Oromia and Dire Dawa. Reporting completeness declined substantially during scale-up. MMS implementation remained broadly aligned with program targets but varied across regions and implementation settings, highlighting the need for strong implementation support, monitoring systems, and data-quality assurance during national expansion.*

Keywords *Ethiopia, Geographic Variation, Implementation Performance, Maternal Nutrition, Multiple Micronutrient Supplementation, Routine Monitoring, Temporal Trends.*

Introduction

Maternal micronutrient deficiencies remain a major public health concern in low- and middle-income countries and are associated with adverse maternal and newborn outcomes, including anemia, preterm birth, low birth weight, fetal growth restriction, and neonatal mortality. Despite improvements in maternal health services, maternal undernutrition and micronutrient deficiencies continue to contribute substantially to the burden of maternal and newborn morbidity in Ethiopia. National survey findings indicate persistent nutritional challenges and regional disparities in maternal health service utilization across the country [16, 17].

Iron and folic acid (IFA) supplementation has long been the standard antenatal nutrition intervention for preventing maternal anemia and neural tube defects. However, evidence from systematic reviews and meta-analyses indicates that Multiple Micronutrient Supplementation (MMS), which contains iron, folic acid, and additional essential vitamins and minerals, provides greater benefits than IFA alone, including reductions in low birth weight, small-for-gestational-age births, and preterm delivery [2-8, 15]. Consequently, MMS is increasingly recognized as an effective strategy for improving maternal nutrition and birth outcomes in settings characterized by multiple micronutrient deficiencies [16, 17].

Ethiopia introduced MMS through routine antenatal care services using a phased implementation approach. The program began in 21 pilot woredas across five regions during 2023-2024 and expanded nationally to 75 woredas in 2025 and 80 woredas in 2026 [9, 12]. Scale-up activities included health worker training, supportive supervision, social and behavior change interventions, community engagement, routine performance monitoring, and supply-chain strengthening [18, 19].

As implementation expanded across diverse geographic and health-system contexts,

understanding program performance became increasingly important for informing policy and operational decision-making. Differences in health-system capacity, commodity availability, reporting systems, supervision, and community engagement may influence MMS implementation performance across regions and implementation settings. Although routine monitoring systems provide valuable opportunities to assess implementation performance during scale-up, evidence describing temporal trends and geographic variation in MMS implementation performance in Ethiopia remains limited. Generating such evidence is important for identifying areas requiring additional implementation support and for informing equitable national scale-up.

International agencies, including WHO, UNICEF, Nutrition International, and the Children's Investment Fund Foundation (CIFF), increasingly support MMS implementation and scale-up efforts globally [1, 9, 11].

Study Objective

This study aimed to assess temporal trends and geographic variation in Multiple Micronutrient Supplementation implementation performance in Ethiopia using routine program monitoring data collected between January 2023 and June 2026.

Methods

Study Design

A longitudinal secondary analysis of routine MMS program monitoring data was conducted using reports submitted from implementation woredas between January 2023 and June 2026.

Study Setting

The study was conducted in Ethiopia. MMS implementation began in 21 pilot woredas across five regions (Oromia, SNNP, Sidama, Somali, and Gambella) during 2023–2024. The program expanded nationally to 75 woredas in 2025 and 80 woredas in 2026.

Data Source

Data were obtained from the national MMS routine monitoring database. Monthly reports included information on MMS achievement, supply availability, supportive supervision, health worker training, community engagement activities, and other implementation indicators routinely collected through the national MMS monitoring system.

Unit of Analysis

The unit of analysis was the woreda-month observation. The routine MMS monitoring database initially contained 2,820 records. Following data cleaning, removal of duplicate observations, and exclusion of multiple submissions for the same woreda-month reporting period, the final analytical dataset comprised 2,268 unique woreda-month observations. The process of data cleaning, record selection, duplicate removal, and derivation of the final analytical dataset is illustrated in Figure 1.

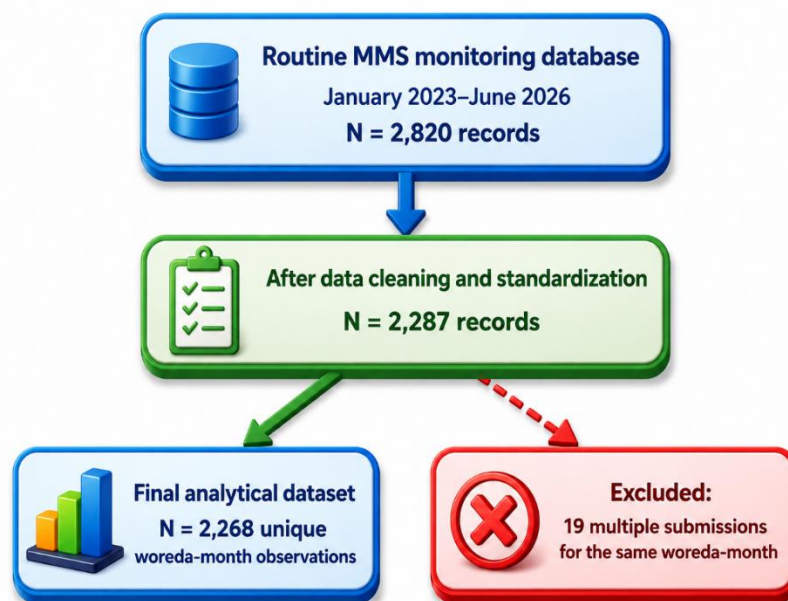


Figure 1. Flow diagram of Routine MMS Monitoring Data Processing and Selection of the Final Analytical Dataset, Ethiopia, January 2023-June 2026

Outcome Variable

MMS achievement was calculated as:

$$\text{MMS Achievement (\%)} = \frac{\text{Number of pregnant women newly supplemented with MMS}}{\text{Monthly target number of pregnant women}} \times 100$$

Observations with missing or zero monthly targets were excluded from MMS achievement calculations. Values exceeding 100% were retained because achievement represents performance relative to reported program targets rather than population coverage.

Statistical Analysis

Descriptive analyses were conducted to summarize dataset characteristics, MMS achievement, temporal trends, geographic variation, and data completeness. Continuous variables were described using means, standard deviations, medians, interquartile ranges (IQRs), minimums, and maximums, whereas categorical variables were summarized using frequencies and percentages.

Because MMS achievement showed a markedly right-skewed distribution (skewness = 3.30), non-parametric statistical

methods were used for inferential analyses. Differences in MMS achievement across regions and reporting periods were assessed using the Kruskal-Wallis test, followed by Benjamini-Hochberg-adjusted pairwise Wilcoxon tests when appropriate. Regional and temporal effect sizes were quantified using epsilon-squared (ϵ^2).

Differences between Existing and Expansion woredas were assessed using the Wilcoxon rank-sum test, and effect sizes were estimated using the rank-biserial correlation coefficient. Additional analyses compared achievement between 2025 and 2026 separately within Existing and Expansion woredas.

Missing MMS achievement data were summarized overall and stratified by year, region, and implementation status. Primary analyses used available-case observations. Because completeness declined substantially during 2026, temporal comparisons involving this period were interpreted cautiously.

Sensitivity Analyses

Sensitivity analyses evaluated the influence of extreme achievement values, patterns of missing outcome data, and clustering of repeated observations within woredas. A mixed-effects model including calendar year and implementation status as fixed effects and woreda as a random intercept was fitted as a sensitivity analysis to assess consistency with the primary non-parametric findings. Full model outputs are presented in Appendix 1.

A two-sided p-value <0.05 was considered statistically significant. All analyses were conducted using R statistical software (R Foundation for Statistical Computing, Vienna, Austria).

Data Management and Quality Assurance

Data were reviewed for completeness, consistency, duplication, and formatting errors prior to analysis. Outcome and implementation indicators were screened for missing values and implausible entries using descriptive summaries and graphical assessment. Several implausible stockout values were identified as spreadsheet-formatting artifacts and were excluded from interpretation. Data cleaning procedures and analytical decisions were documented to ensure transparency and reproducibility.

Reporting Guidelines

This study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Results

Dataset Characteristics and Data Completeness

The final analytical dataset comprised 2,268 unique woreda-month observations, of which 1,724 (76.0%) had sufficient information to calculate MMS achievement (Table 1).

Table 1. MMS Achievement Data Completeness among Monthly Reporting Observations, by Reporting Period, Ethiopia, January 2023-June 2026

Reporting period	Total observations	Achievement available, n (%)	Achievement missing, n (%)
2023	252	248 (98.4)	4 (1.6)
2024	252	250 (99.2)	2 (0.8)
2025	866	811 (93.6)	55 (6.4)
2026 (Jan–Jun)	898	415 (46.2)	483 (53.8)
Total	2,268	1,724 (76.0)	544 (24.0)

Note: MMS achievement could not be calculated where target or achievement values were missing.

Distribution of MMS Achievement

Among the 1,724 observations with available achievement data, mean MMS achievement was 100.2% (SD = 56.3), while median achievement was 94.6% (IQR: 70.5%–120.4%). Achievement ranged from 0% to

729%, indicating substantial variability in implementation performance. Overall, 752 (43.6%) observations achieved at least 100% of the monthly target. The distribution of MMS achievement categories among observations with available achievement data is presented in Table 2.

Table 2. Distribution of MMS Achievement among Observations with Available Achievement Data, Ethiopia, January 2023–June 2026

Achievement level	n	%
<50%	220	12.8
50–<80%	372	21.6
80–<100%	380	22.0
100–<120%	316	18.3
≥120%	436	25.3
Total	1,724	100.0

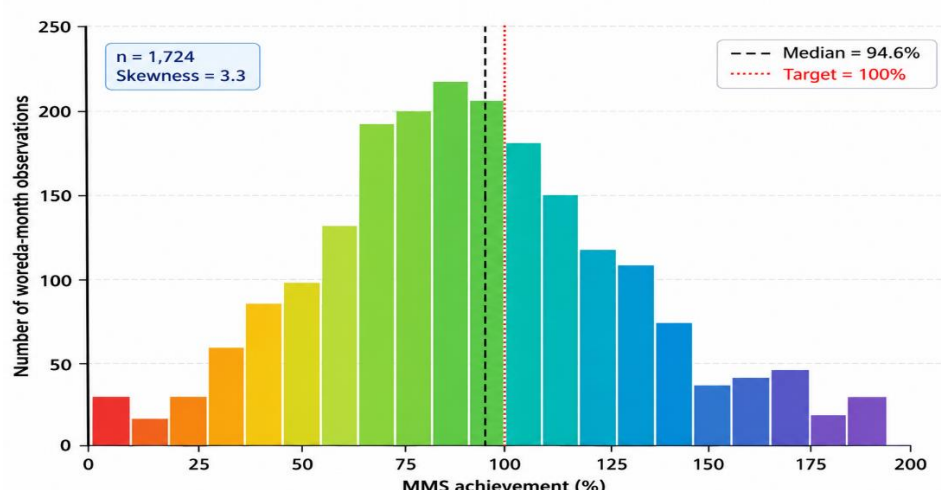


Figure 2. Distribution of MMS Achievement among Reporting Observations, Ethiopia, January 2023–June 2026

Note: The dashed black line indicates the median achievement (94.6%), while the dotted red line indicates the program target (100%). The histogram was truncated at 200% for visualization purposes; all observations were retained in the analysis.

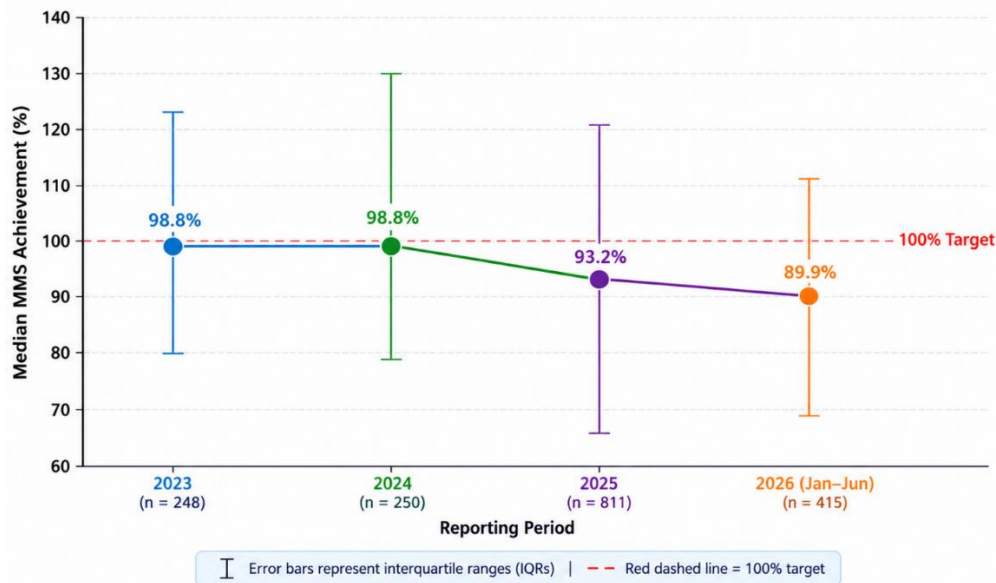
The distribution of MMS achievement was positively skewed, with a small number of observations reporting exceptionally high achievement values (Figure 2). The lower median relative to the mean indicates that overall achievement was influenced by a relatively small number of high-performing observations.

Temporal Trends in MMS Achievement

MMS achievement varied across reporting periods (Table 3, Figure 3). Median achievement remained stable at 98.8% during 2023 and 2024, before declining to 93.2% in 2025 and 89.9% during January–June 2026. Mean achievement exceeded the median in all reporting periods, consistent with the right-skewed distribution of achievement values.

Table 3. MMS Achievement by Reporting Period, Ethiopia, January 2023–June 2026

Reporting period	Total observations, N	Achievement available, n	Missing, n (%)	Median (IQR), %	Mean, %
2023	252	248	4 (1.6)	98.8 (80.0–122.0)	103.0
2024	252	250	2 (0.8)	98.8 (77.0–130.0)	107.0
2025	866	811	55 (6.4)	93.2 (66.4–121.0)	98.4
2026 (Jan–Jun)	898	415	483 (53.8)	89.9 (68.6–112.0)	98.0


Figure 3. Median MMS Achievement by Reporting Period, Ethiopia, January 2023–June 2026

Median achievement was lower during 2025 and January–June 2026 than during 2023–2024; however, the overall reporting-period effect was small ($\epsilon^2 = 0.0077$), and interpretation of 2026 estimates is constrained by substantial missing outcome data.

Achievement of Monthly Targets

Overall, 752 of 1,724 observations (43.6%) achieved at least 100% of the monthly MMS target (Table 4). Achievement rates varied modestly across reporting periods, ranging from 41.8% to 49.2%.

Table 4. Achievement of Monthly MMS Targets among Observations with Available MMS Achievement Data, Ethiopia, January 2023–June 2026

Reporting period	Available observations	Achieved $\geq 100\%$, n	Achievement rate (%)
2023	248	116	46.8
2024	250	123	49.2
2025	811	339	41.8
2026 (Jan–Jun)	415	174	41.9
Total	1,724	752	43.6

These findings indicate that fewer than half of reporting observations achieved their

monthly MMS targets, despite overall mean achievement remaining close to 100%.

MMS Achievement by Woreda Implementation Status

MMS achievement differed between Existing and Expansion woredas (Table 5). Among observations with available outcome

data, median achievement was higher in Existing woredas (96.4%) than in Expansion woredas (85.3%). Achievement data were also more complete in Existing than Expansion woredas (79.4% vs. 69.0%).

Table 5. MMS Achievement and Data Completeness by Woreda Implementation Status, Ethiopia, January 2023–June 2026

Measure	Existing	Expansion
Total observations	1,533	735
Achievement available, n (%)	1,217 (79.4)	507 (69.0)
Missing achievement, n (%)	316 (20.6)	228 (31.0)
Mean achievement (%)	101.0	98.6
SD	44.4	77.9
Median achievement (%)	96.4	85.3
25th percentile (%)	75.9	55.6
75th percentile (%)	120.0	121.0

The Wilcoxon rank-sum test indicated a statistically significant difference in MMS achievement between Existing and Expansion woredas ($W = 345,917$, $p < 0.001$). However, the magnitude of the difference was small (rank-biserial correlation = 0.126).

Geographic Variation in MMS Achievement

MMS achievement varied significantly across regions (Kruskal-Wallis $\chi^2(12) = 99.01$,

$p < 0.001$), indicating geographic heterogeneity in implementation performance. Although statistically significant, the magnitude of regional differences was modest ($\epsilon^2 = 0.051$). Pairwise comparisons with Benjamini-Hochberg adjustment identified significant differences between multiple regional pairs. Detailed regional summaries of MMS achievement and reporting completeness are presented in Table 6.

Table 6. Regional Variation in MMS Achievement among Monthly Reporting Observations, Ethiopia, January 2023–June 2026

Region	Total observations, n	Achievement available, n (%)	Mean (%)	Median, %
Oromia	689	565 (82.0)	108.0	102.0
Dire Dawa	184	120 (65.2)	105.0	102.0
SNNP	288	248 (86.1)	107.0	100.0
Addis Ababa	69	50 (72.5)	95.5	98.2
Gambela	48	39 (81.3)	96.8	96.8
SER	22	12 (54.5)	102.0	90.7
Sidama	96	84 (87.5)	89.4	88.7
Amhara	189	138 (73.0)	88.8	86.7
Benishangul-Gumuz	24	9 (37.5)	84.3	82.1
Harari	207	131 (63.3)	83.9	81.1
Afar	48	33 (68.8)	84.4	79.4

Tigray	216	147 (68.1)	118.0	77.3
Somali	188	148 (78.7)	78.1	64.1
Total	2,268	1,724 (76.0)	—	—

Note: Regional estimates should be interpreted cautiously for regions with small numbers of observations, particularly SER ($n = 22$) and Benishangul-Gumuz ($n = 24$).

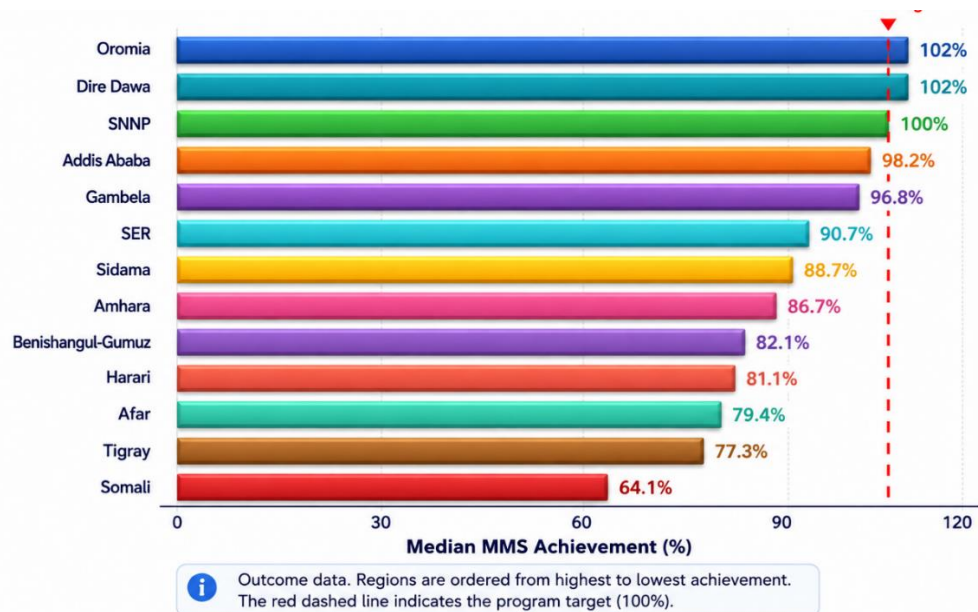


Figure 4. Regional Variation in Median MMS Achievement among Reporting Observations, Ethiopia, January 2023-June 2026

Note: Values represent median MMS achievement among observations with available achievement data.

Median MMS achievement ranged from 64.1% in Somali Region to 102.0% in Oromia and Dire Dawa (Figure 4). Tigray reported the highest mean achievement (118.0%) but a substantially lower median achievement (77.3%), suggesting a strongly right-skewed distribution influenced by a small number of high-achievement observations.

Data Quality and Reporting Completeness

Data completeness varied substantially across MMS monitoring indicators. MMS achievement data were missing for 544 (24.0%) of the 2,268 woreda-month observations. Missingness was higher for several supporting implementation indicators, including community dialogue information (800

observations), awareness-creation information (797 observations), and health-worker training information (876 observations).

Information on three-month supply availability was reported as available in 1,185 (52.2%) observations and unavailable in 192 (8.5%), while 891 (39.3%) observations had missing supply information.

Data-quality concerns were also identified for the stockout indicator. Several records contained implausible values corresponding to spreadsheet date serial numbers rather than valid stockout counts. These observations were interpreted as probable data-entry or formatting errors and were excluded from interpretation. The pattern of MMS achievement data completeness across reporting periods is illustrated in Figure 5.

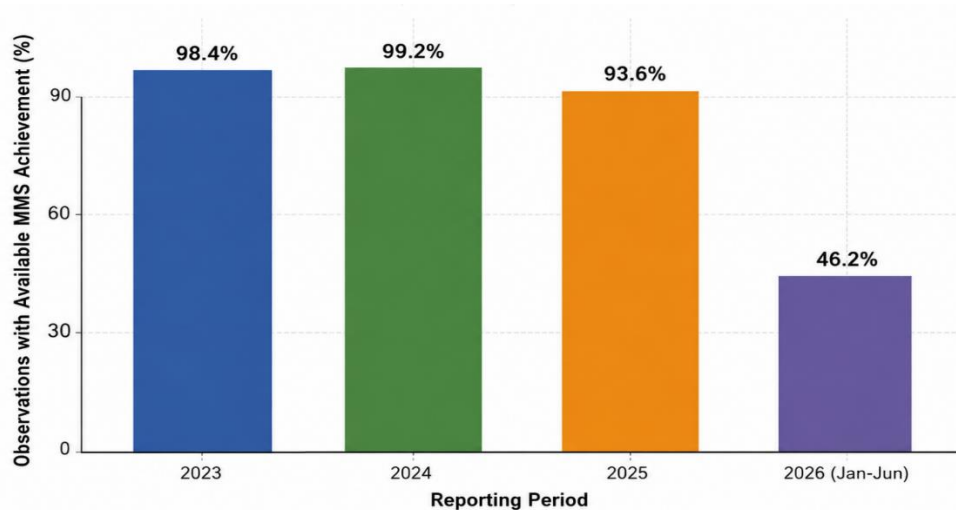


Figure 5. Completeness of MMS achievement data by reporting period, Ethiopia, January 2023–June 2026

Note: Completeness was calculated as the proportion of observations with sufficient information to estimate MMS achievement. Reporting completeness declined substantially during January–June 2026.

Completeness remained above 93% during 2023–2025 but declined sharply to 46.2% during January–June 2026. Missingness exceeded 50% in both Existing and Expansion woredas, indicating that reporting challenges were widespread rather than confined to newly implementing areas.

Sensitivity Analyses

Sensitivity analyses were conducted to assess the robustness of the primary findings. Excluding observations with MMS achievement values exceeding 300% did not

materially alter the distribution of achievement or the principal conclusions (Appendix 2). Similarly, missing outcome data during January–June 2026 were comparable between Existing and Expansion woredas (53.6% and 54.1%, respectively). A mixed-effects sensitivity analysis accounting for repeated observations within woredas produced findings consistent with the primary non-parametric analyses (Appendix 1). A summary of the principal inferential analyses is presented in Table 7.

Table 7. Summary of Inferential Analyses of MMS Achievement, Ethiopia, January 2023–June 2026

Comparison	Statistical test	Test statistic	P-value	Effect size
Region (13 regions)	Kruskal–Wallis	$\chi^2 = 99.008$ (df = 12)	<0.001	$\epsilon^2 = 0.051$
Reporting period (2023–2026)	Kruskal–Wallis	$\chi^2 = 16.315$ (df = 3)	0.001	$\epsilon^2 = 0.0077$
Existing vs Expansion	Wilcoxon rank-sum	W = 345,917	<0.001	rrb = 0.126
Existing: 2025 vs 2026 (Jan–Jun)	Wilcoxon rank-sum	W = 57,499	0.970	—
Expansion: 2025 vs 2026 (Jan–Jun)	Wilcoxon rank-sum	W = 30,207	0.430	—

Regional differences in MMS achievement were statistically significant but modest in magnitude ($\epsilon^2 = 0.051$), whereas temporal differences across reporting periods were statistically significant but very small ($\epsilon^2 = 0.0077$). Existing woredas achieved significantly higher MMS performance than

Expansion woredas, although the effect size was small (rrb = 0.126). No statistically significant differences were observed between 2025 and January–June 2026 within either implementation-status group.

Discussion

Principal Findings

This study assessed temporal and geographic variation in MMS implementation performance during national scale-up in Ethiopia using routine monitoring data collected between January 2023 and June 2026. Overall, MMS achievement remained close to program targets when summarized by the mean, although the median achievement was lower, indicating substantial variability across reporting observations. Performance differed significantly across regions and implementation settings, with Existing woredas generally achieving higher performance than Expansion woredas. A notable finding was the sharp decline in reporting completeness during January–June 2026, which limits confidence in the interpretation of recent temporal trends.

These findings suggest that MMS implementation performance was generally maintained during scale-up but was characterized by substantial heterogeneity across regions and implementation contexts. Although achievement appeared lower during the most recent reporting period, the combination of small temporal effect sizes and substantial missing outcome data suggests caution in interpreting this pattern as evidence of a meaningful decline in national performance.

Geographic and Implementation Variation

The significant geographic variation observed in this study is consistent with implementation research demonstrating that maternal nutrition interventions often perform differently across health-system and geographic contexts. Differences in service accessibility, workforce capacity, supervision, supply-chain performance, leadership, community engagement, and reporting systems may all contribute to variation in implementation performance [5, 10, 14].

Although regional differences were statistically significant, their overall magnitude was modest, suggesting that region alone explains only a limited proportion of the observed variation. Considerable heterogeneity is likely to exist within regions at woreda and facility levels. Consequently, identifying the operational characteristics associated with high-performing implementation areas may offer greater value for program improvement than focusing solely on regional averages.

Existing woredas achieved higher MMS performance than Expansion woredas; however, the observed effect size was small. This finding is consistent with implementation research showing that newly adopted service-delivery areas often require time to establish reporting systems, provider capacity, supervision mechanisms, and routine operational processes [20, 21]. At the same time, the modest magnitude of the difference suggests that implementation status alone does not account for most of the variability in MMS achievement.

Future studies incorporating facility-level and qualitative data may help explain the operational factors underlying observed geographic differences in MMS implementation performance.

Temporal Trends in MMS Achievement

MMS achievement differed significantly across reporting periods, but the magnitude of the difference was very small ($\varepsilon^2 = 0.0077$). Median achievement remained stable during 2023 and 2024, followed by lower median achievement in 2025 and January–June 2026. The apparent decline therefore coincided temporally with the transition from pilot implementation toward broader national scale-up.

However, the interpretation of this temporal pattern requires caution. The 2026 estimate represents January–June only, rather than a complete calendar year, and achievement data were available for less than half of reporting

observations during this period. Furthermore, within-status comparisons found no statistically significant difference between 2025 and January–June 2026 among either Existing or Expansion woredas.

Taken together, these findings suggest that there is evidence of variation across reporting periods but limited evidence that MMS achievement changed substantially between the two most recent periods within implementation-status groups. The observed decline in the overall 2026 median may therefore reflect a combination of true implementation variation and changes in the composition and completeness of reporting.

This distinction is particularly important for routine program monitoring. Apparent changes in performance should be interpreted alongside changes in reporting completeness and the geographic composition of reporting observations rather than considered in isolation.

Data Quality and Reporting Completeness

Data quality and reporting completeness emerged as some of the most important findings of this study. While MMS achievement data were highly complete during 2023–2025, completeness declined substantially during January–June 2026. Similar challenges were observed across other implementation indicators, including training, community engagement, and supply-monitoring variables.

The timing of this decline coincided with rapid program expansion. Although causality cannot be established from the available data, expansion may have increased demands on reporting systems, supervision structures, and data-management processes. Similar challenges have been reported in routine health information systems during periods of rapid scale-up and system transition [21].

Several stockout records also contained implausible values consistent with spreadsheet-formatting errors, illustrating the vulnerability of manually managed monitoring systems to

data-entry and validation challenges. These findings highlight the importance of viewing data quality as an integral component of implementation performance rather than a separate monitoring activity.

Because more than half of observations lacked achievement data during January–June 2026, estimates from this period should be interpreted as reflecting reporting observations rather than definitive national performance. The similar level of lack missingness among Existing and Expansion woredas suggests that reporting challenges were widespread rather than confined to newly implementing areas.

Implications for National MMS Scale-Up

The findings have several implications for ongoing national MMS implementation. First, implementation support should be targeted toward lower-performing regions and implementation areas identified through routine monitoring. Geographic performance differences suggest that some areas may benefit from additional supervision, mentoring, and operational support.

Second, newly implemented areas may require intensified support during the transition to routine MMS delivery. Structured supervision, commodity-management support, provider training, and routine performance reviews may help strengthen implementation during early phases of expansion.

Third, data quality should be treated as a core implementation outcome. The marked decline in reporting completeness demonstrates that rapid geographic expansion without corresponding investment in monitoring capacity can reduce the usefulness of routine program data for decision-making.

Finally, integration of MMS indicators into national digital health information systems may improve sustainability, standardization, data validation, and reporting completeness. Such investments would strengthen both

implementation monitoring and accountability during future scale-up efforts.

Strengths

This study has several strengths. It utilized routine MMS monitoring data collected during the transition from pilot implementation to national scale-up, providing insight into implementation performance under real-world program conditions. The analysis included 2,268 unique woreda-month observations across 13 regions, offering substantial temporal and geographic coverage. The use of non-parametric statistical methods, effect-size estimation, and sensitivity analyses strengthened the robustness of findings. In addition, the study examined both implementation performance and reporting completeness, providing a broader assessment of program functioning during national expansion.

Limitations

Several limitations should be considered. First, the study relied on routine program monitoring data that were not collected primarily for research purposes and may therefore be affected by reporting inconsistencies, data-entry errors, and variation in indicator quality. Second, MMS achievement data were missing for 24.0% of observations overall and for more than half of observations during January-June 2026, potentially introducing bias if missingness was related to implementation performance. Third, the 2026 data represent only the first six months of the year, limiting direct comparison with previous reporting periods. Fourth, a small number of extreme achievement values were observed, although sensitivity analyses indicated that these observations did not materially influence the main findings. Finally, the observational design does not permit causal inference, and substantial missingness in several implementation indicators limited exploration

of factors underlying geographic and temporal variation in MMS achievement.

Conclusion

MMS implementation performance in Ethiopia remained broadly aligned with program targets during national scale-up, but substantial variation was observed across regions and implementation settings. Existing implementation areas generally achieved higher performance than newly expanded woredas, while geographic differences highlighted the importance of local implementation context. Although achievement appeared lower during the most recent reporting period, interpretation of this pattern is constrained by the marked deterioration in reporting completeness.

As Ethiopia continues national MMS expansion, strengthening implementation support, routine monitoring systems, data quality assurance, and reporting completeness will be essential to ensure equitable and sustainable program delivery. Particular attention should be given to lower-performing areas and newly implementing woredas to support consistent implementation and maximize the potential population-health benefits of MMS.

Conflict of Interest

The author declares no conflict of interest regarding the publication of this study.

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Author Contributions

Abnet Tesfaye Kebede conceived the study, conducted the data analysis, interpreted the findings, and prepared the manuscript.

Ethics Approval

This study utilized secondary analysis of routinely collected, aggregated MMS program monitoring data and did not involve direct contact with human participants. The dataset contained no personal identifiers and was analyzed solely for research purposes.

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Data Availability

The data used in this study are derived from the national MMS routine monitoring system and are not publicly available. Access may be granted by the relevant program authorities subject to applicable permissions and data-sharing requirements.

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