Journal of Rare Cardiovascular Diseases
ISSN: 2299-3711 (Print) | e-ISSN: 2300-5505 (Online)
www.jrcd.eu
RESEARCH ARTICLE

Temporal Disparities and Pass-Through Patterns in Obstetric Referrals: A Prospective Analysis from Eastern India's Tribal Communities

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Article History
Received: 10.09.2025
Revised: 24.09.2025
Accepted: 06.10.2025
Published: 27.10.2025

Abstract: Effective referral systems are critical for reducing maternal mortality in tribal populations. However, limited evidence exists on the referral patterns and quality in India's Particularly Vulnerable Tribal Group districts. This study analyzed the temporal variations in obstetric referrals and pre-referral management quality in a tribal-dominated district of Odisha. Methods: A prospective observational study was conducted at the District Headquarters Hospital, Gajapati District, Odisha, from January 2024 to February 2025. All maternal referrals during 2,759 deliveries were analyzed using specialized data collection protocols. Temporal patterns were assessed using correlation analysis and time series modelling with SPSS (version 26.0). Results: Among 2,759 deliveries, 909 (32.9%) were referred inward, and 451 (16.3%) were referred outward. Strong correlations were observed between daytime referrals-in and total referrals-in ($r=0.862$, $p<0.001$) and nighttime referrals-out and total referrals-out ($r=0.875$, $p<0.001$). Nighttime referrals-in correlated significantly with nighttime referrals-out ($r=0.571$, $p=0.033$). Pre-referral management varied considerably, with the highest scores for birth asphyxia (mean=8.0, SD=5.0) and absent management for postpartum hemorrhage and delayed labor progress (mean=0.0, SD=0.0). Time series analysis demonstrated a good model fit ($R^2=0.725$). Conclusions: Significant temporal disparities exist in referral patterns, with a potential pass-through phenomenon during nighttime. Substantial gaps in pre-referral management highlight the urgent need for standardized protocols in tribal healthcare settings.

Keywords: maternal health, obstetric referrals, tribal populations, pre-referral management, healthcare delivery, India.

INTRODUCTION

Maternal healthcare referral systems constitute a cornerstone of effective healthcare delivery, particularly in resource-constrained settings serving vulnerable populations. [1–3] Globally, effective and timely referral mechanisms are essential components of comprehensive emergency obstetric care (EmOC), designed to ensure timely access to appropriate levels of care for pregnant women experiencing complications. [4–6]

The three-tiered public healthcare system in India, comprising Primary Health Centers (PHCs), Community Health Centers (CHCs), and District Headquarters Hospitals (DHHs), forms the backbone of maternal healthcare delivery in rural and tribal regions.[7,8] This hierarchical system relies on effective referral mechanisms to ensure that women with obstetric complications identified at peripheral facilities are stabilized and promptly referred to higher-level centers, such as CHCs or DHHs, which are designated as First Referral Units (FRUs) capable of providing EmOC.[9,10]

Tribal populations in India face unique and compounded challenges in accessing maternal healthcare services. These communities often experience geographical isolation, socio-cultural beliefs that may discourage institutional care, transportation difficulties, and economic constraints that complicate healthcare-seeking behaviors.[10–13] The "three delays" framework, which identifies delays in deciding to seek care, reaching appropriate facilities, and receiving adequate and appropriate quality care upon arrival, provides a useful lens for understanding maternal mortality patterns in these settings.[2,14]

Odisha state, with a 22.85% tribal population, is home to 13 of India's 75 Particularly Vulnerable Tribal Groups (PVTGs).[15] These communities represent some of the most marginalized populations in the country, facing significant healthcare disparities, including significantly poorer maternal health indicators than mainstream populations.[16,17] Despite government initiatives, such as the Janani Shishu Suraksha Karyakram (JSSK), to improve maternal health outcomes, tribal communities continue to experience challenges in accessing and utilizing quality maternal healthcare services.[18–20]

Recent studies have highlighted that while some PVTG populations in Odisha have achieved utilization rates comparable to the national averages for certain maternal health indicators, significant gaps remain in institutional delivery rates and quality of care. The persistence of these disparities indicates that tailored approaches are

required to effectively address maternal health challenges in tribal communities.[19,21]

Understanding referral patterns and their temporal variations is crucial for optimizing maternal healthcare delivery systems.[22] However, limited research has examined the specific dynamics of obstetric referrals in tribal districts, particularly regarding day-night variations in referral patterns and the quality of pre-referral stabilization and management provided at lower-level facilities before transfer.[23–25]

This study addresses critical knowledge gaps by examining maternal referral patterns in the Gajapati district of Odisha, a predominantly tribal district with a significant PVTG population. The specific objectives were to (1) analyze temporal patterns of obstetric referrals, including day-night variations; (2) assess correlations between delivery volumes and referral dynamics; (3) evaluate the quality of pre-referral management for common obstetric complications; and (4) identify system-level factors influencing referral effectiveness in tribal healthcare contexts.

MATERIAL AMND METHODS

Study Design and Setting

This prospective observational study was conducted at the Maternal and Child Health (MCH) unit of the District Headquarters Hospital (DHH), Paralakhemundi, Gajapati District, Odisha, India. The study period extended from January 2024 to February 2025, encompassing 14 months of comprehensive data collection.

DHH Paralakhemundi serves as the sole First Referral Unit (FRU) for this tribal-dominated district, functioning as a 161-bedded facility within the apex tier of the district's healthcare network. Gajapati district comprises 30 government healthcare facilities, including one DHH, 8 CHCs, and 21 PHCs, serving a population with significant representation of PVTGs [26].

Study Population

The study population included all pregnant women who delivered at the Maternal Child Health (MCH) unit during the study period, as well as those referred to or from the facility for obstetric care. During the 14-month observation period, 2,759 deliveries were conducted at the facility, with 909 cases referred from lower-level facilities and 451 cases referred to higher-level tertiary care centers.

Data Collection

Data collection was performed using a specialized checklist designed specifically for this study to systematically document the referral parameters. The checklist captured comprehensive information, including the following:

1. Demographic information of referred patients
2. Temporal data (date and time of referral, categorized as day [8 AM to 8 PM] or night [8 PM to 8 AM]
3. Source facility for referrals-in and destination facility for referrals-out
4. Primary reason for referral
5. Clinical status at the time of referral
6. Pre-referral management provided at referring facilities
7. Mode of transportation used
8. Time taken for transfer
9. Maternal and foetal outcomes

Variables and Measurements

The primary variables analyzed included:

- **Delivery volume**: Total number of deliveries conducted at the MCH unit each month
- **Referral-in rate**: Number of obstetric cases referred to the DHH from lower-level facilities
- **Referral-out rate**: Number of obstetric cases referred from the DHH to higher-level tertiary care centres
- **Temporal patterns**: Distribution of referrals across day and night periods

The pre-referral management assessment focused on minimum essential management provided before referral for specific complications, including:

- Administration of antibiotics for premature rupture of membranes (PROM)
- Use of partograph for monitoring labour progress
- Administration of antenatal corticosteroids for preterm labour
- Magnesium sulphate administration for eclampsia and pre-eclampsia
- Initial management of obstetric haemorrhage
- Neonatal resuscitation measures for birth asphyxia
- Initiation of treatment for maternal and neonatal sepsis
- Preliminary management for severe anaemia

Data Analysis

Data analysis was performed using SPSS (Statistical Package for Social Sciences) version 26.0.[27] The analytical approach included the following:

Descriptive statistics: Computation of frequencies, percentages, means, and standard deviations to characterize the monthly delivery volumes and referral patterns.

Correlation analysis: Pearson's correlation coefficients were calculated to examine the relationships between:

- Total deliveries and total referrals (both in and out)
- Daytime and nighttime referral patterns
- Referral-in and referral-out volumes

Time series analysis: A simple trend analysis was conducted to identify patterns in monthly delivery trends and referral dynamics over the 14-month observation period. Model fit statistics included

stationary R-squared, RMSE (Root Mean Square Error), MAPE (Mean Absolute Percentage Error), MaxAPE (Maximum Absolute Percentage Error), MAE (Mean Absolute Error), MaxAE (Maximum Absolute Error), and Normalized BIC (Bayesian Information Criterion).

Quality assessment: Pre-referral management adherence was evaluated using mean scores and standard deviations calculated for each condition.

Statistical significance was set at $p<0.05$ for all analyses. Both Pearson's R and Spearman's correlation coefficients were computed to account for both linear and non-linear relationships, with asymptotic standard errors and approximate T-values reported to assess the reliability of correlation estimates.

Ethical Considerations

The study was conducted according to the Declaration of Helsinki and approved by the Institutional Ethics Committee of Medipulse Hospital, Jodhpur (approval no. MH/IEC/2024/BHR/0007, September 11, 2024). Permission was obtained from the Chief District Medical and Public Health Officer (CDM &PHO) of the Gajapati district. All data were anonymized to protect the patients' confidentiality. As this was an observational study of routine clinical data, the requirement for individual informed consent was waived by the ethics committee, adhering to the Declaration of Helsinki principles for medical research involving human subjects.

RESULTS AND OBSERVATIONS:

Overview of Deliveries and Referrals

During the 14-month study period, 2,759 deliveries were conducted at the MCH unit of the District Headquarters Hospital. The monthly delivery count ranged from 88 to 230, with a mean of 197.07 (SD=33.269). Throughout this period, the facility received 909 referrals (referred in) and transferred 451 patients to higher-level facilities (referred out). The referral-in and referral-out rates were 32.9% and 16.3% of total deliveries, respectively.

Table 1: Monthly Delivery and Referral Data (January 2024 - February 2025)

Temporal Analysis of Referral Patterns

Analysis of day-night referral patterns revealed significant temporal variations in the referral dynamics.

Table 2: Correlation Analysis - Daytime Referrals In and Total Referrals In

Daytime referrals-in (8 AM to 8 PM) showed a strong positive correlation with total referrals-in (Pearson's R=0.862, $p<0.001$). The Spearman correlation coefficient (0.855, $p<0.001$) further confirmed this strong relationship, indicating that variations in daytime referrals strongly predicted the overall referral-in pattern at the facility.

Table 3: Correlation Analysis - Nighttime Referrals In and Total Referrals In

Nighttime referrals-in (8 PM to 8 AM) demonstrated a moderate positive correlation with total referrals-in (Pearson's R=0.466), although this relationship was not statistically significant (p=0.093). The Spearman correlation coefficient (0.310, p=0.281) also showed a weak positive relationship, suggesting that nighttime referrals contribute less consistently to the overall referral-in pattern than daytime referrals.

Table 4: Correlation Analysis - Nighttime Referrals In and Nighttime Referrals Out

A significant positive correlation was observed between nighttime referrals-in and nighttime referrals-out (Pearson's R=0.571, p=0.033), indicating that increases in nighttime referrals-in are associated with increases in nighttime referrals-out, suggesting a potential "pass-through" phenomenon during the night hours.

Figure 1: Pass-Through Phenomenon in Nighttime Obstetric Referrals

Table 5: Day-Night Referral Distribution Analysis

The analysis showed that the facility received more referrals during the daytime (M=41.07, SD=9.352) than during the nighttime (M=24.57, SD=4.847). Similarly, more patients were referred during the daytime (M=16.29, SD=4.159) than during the nighttime (M=15.93, SD=6.545), although this difference was smaller.

Correlation Between Deliveries and Referrals

Correlation analysis revealed weak negative correlations between total deliveries and total referrals-in (r=-0.144, p=0.625) and between total deliveries and total referrals-out (r=-0.153, p=0.602). A weak positive correlation was observed between total referrals-in and total referrals-out (r=0.166, p=0.571). None of these correlations reached statistical significance, suggesting that the volume of deliveries at the facility was not strongly related to either incoming or outgoing referrals.

Time Series Analysis Results

The time series analysis of monthly delivery trends and referral patterns demonstrated a good model fit with an R-squared value of 0.725, indicating that the model explained 72.5% of the variance in data. Additional fit statistics included RMSE of 18.973, MAPE of 6.311, MaxAPE of 26.909, MAE of 10.570, MaxAE of 37.506, and Normalized

BIC of 6.452. These metrics suggest that the time series model provided a reliable framework for understanding the temporal patterns of deliveries and referrals at the facility over the study period.

Pre-referral Management Quality Assessment

An analysis of the minimum pre-referral management for various conditions showed considerable variation in adherence to protocols. Birth asphyxia cases received the highest level of pre-referral management (Mean=8.0, SD=5.0), followed by premature rupture of membranes (Mean=4.0, SD=2.0) and eclampsia (Mean=4.0, SD=3.0). Severe pre-eclampsia cases also received substantial pre-referral management (mean =3.4, SD=3.0).

Moderate levels of pre-referral management were observed for obstructed labor (Mean=2.0, SD=3.0) and preterm labor (Mean=2.0, SD=2.0). Lower levels were noted for fetal distress (Mean=1.0, SD=2.0), neonatal sepsis (Mean=1.0, SD=3.0), and severe anemia (Mean=1.0, SD=1.0). Delayed progress of labor and postpartum hemorrhage showed no recorded pre-referral management (Mean=0.0, SD=0.0), while maternal sepsis had minimal management (Mean=0.0, SD=1.0).

variability in standard deviations across these conditions indicates the inconsistent application of pre-referral management protocols, with some conditions showing more standardized care than others.

Figure 2: Pre-Referral Management Quality Assessment by Complication Type

Tables

Table 1: Monthly Delivery and Referral Data (January 2024 - February 2025)

Month	Total Deliveries	Total Referred In	Total Referred Out
Jan-24	88	66	37
Feb-24	215	57	37
Mar-24	195	44	31
Apr-24	218	65	34
May-24	199	72	44
Jun-24	200	72	43
Jul-24	206	76	44
Aug-24	230	58	25
Sep-24	209	58	27
Oct-24	215	52	30
Nov-24	201	74	30
Dec-24	195	74	30
Jan-25	189	67	25
Feb-25	199	74	14
Total	**2,759**	**909**	**451**

Table 2: Correlation Analysis - Daytime Referrals In and Total Referrals In

Correlation Type	Value	Asymptotic Standard Error	Approximate T	Significance
Pearson's R	0.862	0.053	5.891	<0.001
Spearman Correlation	0.855	0.099	5.713	<0.001

Table 3: Correlation Analysis - Nighttime Referrals In and Total Referrals In

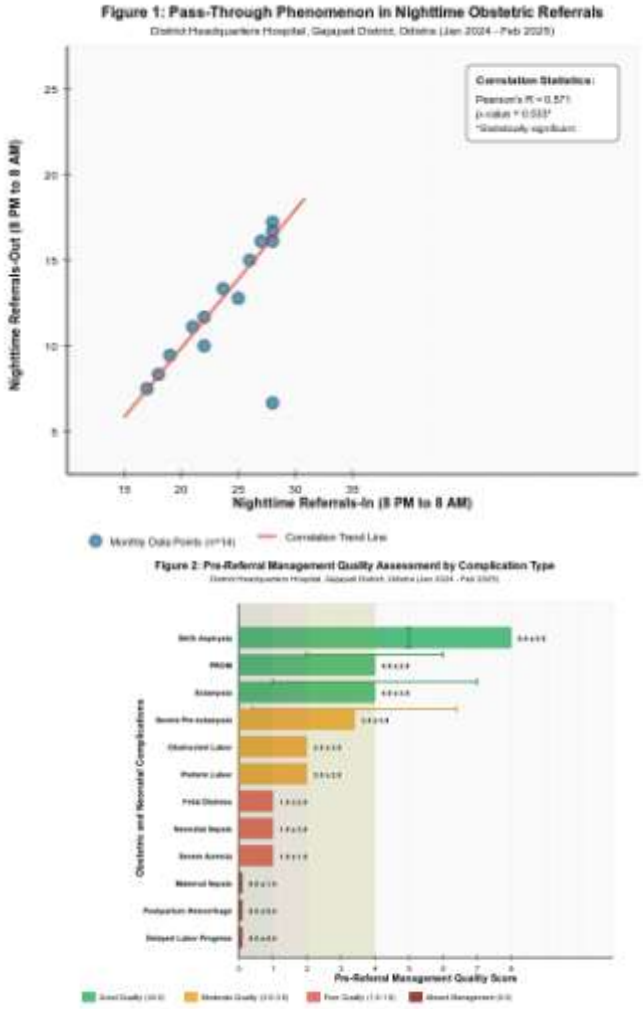
Correlation Type	Value	Asymptotic Standard Error	Approximate T	Significance
Pearson's R	0.466	0.225	1.824	0.093
Spearman Correlation	0.310	0.335	1.128	0.281

Table 4: Correlation Analysis - Nighttime Referrals In and Nighttime Referrals Out

Correlation Type	Value	Asymptotic Standard Error	Approximate T	Significance
Pearson's R	0.571	0.155	2.060	0.033
Spearman Correlation	0.507	0.202	2.039	0.064

Table 5: Day-Night Referral Distribution Analysis

Referral Type	Mean	Standard Deviation
Day Referrals-In (8 AM to 8 PM)	41.07	9.352
Night Referrals-In (8 PM to 8 AM)	24.57	4.847
Day Referrals-Out (8 AM to 8 PM)	16.29	4.159
Night Referrals-Out (8 PM to 8 AM)	15.93	6.545



DISCUSSION

This prospective analysis of obstetric referral patterns in a tribal district of Odisha provides important insights into the functioning of maternal healthcare delivery systems that serve vulnerable populations. The findings reveal significant temporal disparities, quality gaps in pre-referral management, and concerning patterns that suggest inadequate emergency obstetric care capacity during critical periods.28,29

Temporal Disparities in Referral Patterns

The strong correlation between daytime referrals-in and total referrals-in (r=0.862, p<0.001) contrasted markedly with the weaker correlation observed during nighttime hours (r=0.466, p=0.093). This finding highlights pronounced diurnal variations in healthcare-seeking behaviour and referral decision-making processes. Such temporal disparities likely reflect multiple factors, including transportation availability, family decision-making patterns, and provider readiness at referring facilities during different periods.30

The significant correlation between nighttime referrals-in and nighttime referrals-out (r=0.571, p=0.033) suggests a concerning "pass-through" phenomenon, in which patients referred during night hours are subsequently transferred to higher facilities without substantial intervention at the district hospital level. This pattern indicates potential limitations in the facility's capacity to manage complex obstetric emergencies during nighttime hours, raising important

questions about staffing patterns, resource availability, and provider confidence in managing critical cases during night shifts.31

Quality Gaps in Pre-referral Management

Substantial variations in the quality of pre-referral management represent a critical finding with immediate clinical implications. Birth asphyxia received the highest management scores (mean=8.0, SD=5.0), likely reflecting the widespread recognition of neonatal resuscitation as an essential clinical skill. However, the high standard deviation indicates inconsistent application, even for this well-recognized emergency condition.

Figure 2 starkly visualizes the quality disparities in pre-referral management. The complete absence of pre-referral management for postpartum haemorrhage and delayed labour progress (both mean=0.0, SD=0.0) is particularly concerning, given that these conditions are among the leading direct causes of maternal mortality globally.32 The inability to provide initial stabilization measures before referral significantly compromises patient outcomes and suggests fundamental gaps in the emergency obstetric care capacity at peripheral facilities.

The color-coded representation in Figure 2 immediately highlights the critical quality gaps: while birth asphyxia, PROM, and eclampsia receive relatively good management (green bars), conditions such as postpartum haemorrhage show virtually no pre-referral intervention (dark red minimal bars). This visualization powerfully demonstrates the need for urgent interventions in the referral system.

Independence of Referral Patterns from Delivery Volumes

The absence of significant correlations between total deliveries and referral patterns challenges the conventional assumptions regarding healthcare utilization dynamics. This finding suggests that referral decisions are influenced more by case complexity, provider capacity, and institutional factors than by patient volumes. Such independence indicates that referral system effectiveness depends on qualitative factors, including provider competency, facility readiness, and case-specific clinical decision-making, rather than simple patient load considerations.21,33

Implications for Health System Strengthening

The temporal disparities identified highlight the urgent need for enhanced night-shift capabilities, including improved staffing patterns, targeted training initiatives, and resource allocation to ensure 24-hour readiness for complex obstetric cases.1 The variability in pre-referral management suggests that standardization of protocols, coupled with regular training and supportive supervision, could significantly improve the quality of initial care before referral.34

Enhanced communication systems between referring and receiving facilities could improve coordination and ensure appropriate preparation for incoming referrals.23 The significant correlation between nighttime referrals-in and referrals-out suggests that improved night-shift capacity at the district level could reduce unnecessary onward referrals and improve overall system efficiency.33

Context-Specific Considerations for Tribal Healthcare

These findings must be interpreted within the specific context of tribal healthcare delivery, where communities face multiple intersecting barriers, including geographical isolation, cultural preferences, economic constraints, and historical marginalization from mainstream healthcare services.35,36 The achievement of relatively high referral utilization rates suggests that institutional barriers may be more amenable to intervention than previously assumed, provided appropriate strategies are implemented.37

Study Limitations

As a single-center study, its generalizability to other tribal districts or healthcare settings may be limited. The observational nature of the study precludes definitive causal inferences regarding the observed associations. The 14-month observation period, although substantial, may not capture longer-term trends or seasonal variations. Additionally, the study documents referral patterns and quality gaps but does not provide direct insights into healthcare provider decision-making processes or patient experiences in the referral system.

Future Research Directions

Future research should explore provider decision-making processes during different shifts, patient-centred experiences of care during referrals, and intervention studies testing standardized pre-referral protocols and enhanced communication systems. Comparative studies across different tribal districts could help identify best practices and adaptable strategies for improving the effectiveness of the referral system.

CONCLUSION

This analysis reveals temporal disparities in obstetric referral systems for tribal populations in Eastern India. The correlation between daytime referrals and overall patterns, contrasted with weaker nighttime correlations, indicates the need for enhanced night-shift capabilities. The association between nighttime referrals-in and referrals-out suggests facility limitations during critical hours, representing an undocumented "pass-through" phenomenon in tribal healthcare.

The variability in pre-referral management, from comprehensive care for birth asphyxia to the absence of intervention for postpartum haemorrhage, shows the need for standardized protocols. The independence of

referral patterns from delivery volumes indicates that factors beyond patient load drive referrals.

For tribal populations, these findings emphasize the need to address supply side factors (provider capacity, facility readiness) and demand-side considerations (cultural appropriateness, geographical access). Strengthening maternal healthcare referral systems requires addressing systemic inequities while building a responsive care system.

The evidence provides targets for addressing the nighttime pass-through phenomenon through enhanced district-level emergency obstetric care and implementing pre-referral management protocols for life-threatening conditions. These findings are relevant to maternal health programs in tribal regions worldwide.

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