

Provincial Implementation and Centralization of Intrapartum Services Through Thailand's First "One Labor Room, One Province" Model: A Seven-Year Before-After Study of Maternal and Perinatal Outcomes

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Background: Pattani Province has long reported maternal and perinatal outcomes poorer than the national averages due to fragmented intrapartum services, delayed referrals, and limited access to obstetric specialists. High proportions of preventable maternal deaths in the southern-border region further highlighted the need for system-wide restructuring. The "One Labor Room, One Province" (OLOP) model was developed to integrate real-time specialist teleconsultation, standardized clinical guidelines, and a seamless referral pathway across district hospitals. Early performance led to Pattani becoming the first province in Thailand to receive Hospital Network Accreditation (HNA) for a province-wide obstetric service network, followed by Provincial Network Certification (PNC), confirming readiness for full-scale implementation.

Objective: To compare adverse maternal and perinatal outcomes Before and After implementation of the OLOP model.

Materials and Methods: A Before and After comparative analysis was conducted among referred deliveries to Pattani Provincial Hospital, including 2,357 cases in 2015 to 2017 (Before) and 2,990 cases in 2021 to 2023 (After). Categorical outcomes were analyzed using chi-square tests, with odds ratios (OR) and 95% confidence intervals (CI) calculated for the After versus Before periods.

Results: Following implementation, severe pregnancy-induced hypertension increased from 14.5% to 18.1% (OR 1.30, 95% CI 1.12 to 1.51), reflecting earlier detection and referral. Antepartum hemorrhage rose from 0.13% to 0.57% (OR 6.33, 95% CI 1.46 to 27.58), and NICU admissions increased from 21.7% to 24.3% (OR 1.16, 95% CI 1.02 to 1.32). Birth asphyxia decreased significantly from 6.41% to 4.35% (OR 0.66, 95% CI 0.52 to 0.85). Direct maternal mortality declined from 61.66 to 26.14 per 100,000 live births, consistent with improved timely referral and intrapartum management. Rates of preterm labor and thick meconium showed no statistically significant change.

Conclusion: Implementation of the OLOP model, grounded in an accredited provincial obstetric service network (HNA and PNC), enhanced early detection and referral of high-risk pregnancies while significantly reducing birth asphyxia and direct maternal mortality. Centralized specialist oversight combined with standardized referral pathways represents an effective system-level strategy for improving intrapartum safety in resource-limited provincial settings.

Keywords: One Labor Room One Province; Intrapartum centralization; Maternal outcomes; Perinatal outcomes; Referral system

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Maternal and perinatal outcomes in Pattani Province had remained poorer than national averages for more than a decade, with increasing trends in direct maternal mortality and preventable obstetric complications. A regional review indicated that over

half of maternal deaths in the three southern-border provinces between 2018 and 2023 were preventable, resulting from postpartum hemorrhage, hypertensive disorders, infection, and delays in intrapartum management⁽¹⁾. Fragmented intrapartum services, inconsistent clinical competency among on-call physicians, limited access to obstetric specialists, and delayed referrals contributed to these outcomes.

Evidence shows that structured clinical management, timely referral, and adherence to standardized obstetric guidelines can reduce high-risk conditions such as preterm labor, birth asphyxia, meconium aspiration syndrome, and obstetric hemorrhage⁽²⁻⁶⁾. Earlier findings from Pattani also identified inadequate antenatal care and gestational diabetes as contributors to severe pre-

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eclamptic complications⁽⁷⁾, underscoring the need for a coordinated, system-wide reform of intrapartum services.

In response, Pattani initiated the “One Labor Room, One Province” (OLOP) framework as a provincial intrapartum centralization model. The framework incorporated real-time specialist teleconsultation, standardized remote ward rounds, unified clinical practice guidelines, and a seamless referral pathway to reduce diagnostic errors, delays in escalation, and variability in intrapartum decision-making. Early implementation strengthened coordination across district hospitals and improved consistency of clinical oversight.

Building on these gains, Pattani became the first province in Thailand to receive Hospital Network Accreditation (HNA) in 2018 for an integrated province-wide obstetric service network, followed by Provincial Network Certification (PNC), demonstrating system readiness, governance quality, and sustainability. These milestones positioned Pattani as the national leader in developing a fully integrated provincial intrapartum model.

Given the province’s longstanding burden of preventable maternal and perinatal morbidity and the structural reforms achieved under the OLOP framework, evaluation of its impact became necessary. The present analysis compared maternal and perinatal indicators Before and After full implementation of the OLOP model over a seven-year period.

MATERIALS AND METHODS

Study design and setting

The present study was a comparative Before and After implementation study conducted at Pattani Provincial Hospital, the tertiary referral center for all district hospitals in Pattani Province. The “Before” period was between 2015 and 2017, and represented the pre-intervention system, while the “After” period was between 2021 and 2023, and represented the fully implemented OLOP model. The years 2018 to 2020 were excluded because they constituted the phased roll-out and stabilization phase of the OLOP system. Ethical approval was obtained from the Pattani Provincial Hospital Research Ethics Committee (PTN-004-2567).

Population and data sources

All referred pregnant women admitted to the Pattani Hospital labor room from network hospitals during the study periods were eligible. Inclusion

criteria were 1) gestational age of 26 weeks or longer, 2) singleton or twin gestation, 3) viable fetus on admission, and 4) complete delivery records. Exclusion criteria were 1) women who delivered primarily at Pattani Hospital without referral, 2) known major fetal anomalies, and 3) intrapartum fetal demise prior to referral. Two thousand three hundred fifty-seven women in the Before period and 2,990 in the After period met the criteria. Data was abstracted from electronic medical records and referral documents, then entered into statistical software for analysis.

Intervention: OLOP

OLOP is a province-wide intrapartum centralization model comprising four components:

1. Daily specialist oversight: Remote morning rounds at all district labor rooms and real-time Tele-Line VDO consultations for urgent cases by Pattani obstetricians.
2. Seamless Referral System: Fast-track, auto-refer, and standardized criteria-based referral pathways to reduce delays and referral rejection.
3. Unified clinical practice guidelines: Standard obstetric protocols applied across all hospitals in the network.
4. Routine root-cause analysis (RCA): Structured reviews of severe morbidities and maternal deaths to drive continuous quality improvement.

Outcomes

Primary outcomes were severe pregnancy-induced hypertension, antepartum hemorrhage (APH) as placenta previa or abruption, preterm labor, thick meconium, birth asphyxia, and neonatal intensive care unit (NICU) admission. Maternal mortality, direct and indirect causes, was summarized and reviewed using RCA reports.

Statistical analysis

Categorical variables were summarized as frequencies and percentages. Comparisons between periods used chi-square tests. Odds ratios (OR) with 95% confidence intervals (CI) were calculated from contingency tables. A two-sided p-value of less than 0.05 was considered statistically significant. Multivariate adjustment was not performed because the intervention represented a province-wide system redesign rather than an individual-level exposure. The objective was to evaluate overall population-level changes attributable to the new intrapartum care model. Statistical analyses were performed using

RESULTS

Two thousand three hundred fifty-seven referred deliveries were included in the Before period and 2,990 in the After period. The proportion of provincial deliveries referral increased from 44% Before OLOP implementation to 56% After implementation, indicating greater utilization of the centralized referral system.

Several demographic and obstetric characteristics differed between periods (Table 1). After OLOP implementation, there were higher proportions of women aged of 35 years and older, grand multiparas, and women with fewer than eight antenatal care visits, indicating a more complex and higher-risk case mix among referred women in the After cohort.

Gestational diabetes mellitus (GDM) also increased in proportion during the After period. The rise reflected improved screening completeness under unified antenatal care (ANC) and intrapartum guidelines, together with strengthened referral pathways for metabolic or comorbidity-related risks. Earlier detection and more consistent classification may have led to a greater proportion of GDM being appropriately referred rather than managed solely at the district-hospital level. This pattern aligned with the broader shift toward heightened triage sensitivity under OLOP.

In addition to maternal demographics, intrapartum characteristics also shifted between periods. Women in the After cohort had a greater proportion of high-risk clinical presentations at the time of referral, including suspected hypertensive disorders, abnormal labor progression, and fetal heart rate (FHR) abnormalities. These changes were consistent with the increased capacity of district hospitals to identify complications earlier and refer more appropriately under the centralized system.

Regarding mode of delivery, the cesarean delivery rate decreased After OLOP implementation despite the higher-risk referral profile. This reflected improved intrapartum assessment, clearer referral criteria, and more consistent decision-making by on-call physicians under specialist oversight. Conversely, the proportion of normal vaginal deliveries increased, suggesting that intrapartum management became more appropriate and timelier, allowing labor to progress safely without unnecessary operative intervention. Overall, these patterns suggested improved triage, more appropriate

Table 1. Maternal demographic and obstetric characteristics of referred pregnancies before and after OLOP implementation

Maternal & obstetric characteristics	2015 to 2017 (n=2,357) Before; n (%)	2021 to 2023 (n=2,990) After; n (%)	p-value
Age			<0.001
<20 years	215 (9.12)	160 (5.35)	
20 to 34 years	1,661 (70.47)	2,077 (69.46)	
≥35 years	481 (20.41)	753 (25.18)	
GA			0.039
<34 weeks	193 (8.19)	188 (6.29)	
34 to 36 ⁺ weeks	210 (8.91)	297 (9.93)	
37 to 40 weeks	1,228 (52.10)	1,564 (52.31)	
>40 weeks	726 (30.80)	941 (31.47)	
Parity			<0.001
0	949 (40.26)	980 (32.78)	
1 to 3	1,144 (48.54)	1,432 (47.89)	
≥4	264 (11.20)	578 (19.33)	
Number of ANC			<0.001
≥8	1,131 (47.98)	1,074 (35.92)	
<8	1,201 (50.95)	1,889 (63.18)	
No ANC	25 (1.06)	27 (0.90)	
GDM			<0.001
Yes	121 (5.13)	299 (10.00)	
No	2,236 (94.87)	2,691 (90.00)	
CHT			0.64
Yes	28 (1.19)	41 (1.37)	
No	2,329 (98.81)	2,949 (98.63)	
Twin			<0.001
Yes	58 (2.46)	35 (1.17)	
No	2,299 (97.54)	2,955 (98.83)	
Mode of delivery			<0.001
NVD	880 (37.34)	1,306 (43.68)	
C/S	1,477 (62.66)	1,684 (56.32)	

GA=gestational age; ANC=antenatal care; GDM=gestational diabetes mellitus; CHT=chronic hypertension; NVD=normal vaginal delivery; C/S=cesarean section

* Statistically significant, p<0.05

case selection for referral, and more standardized delivery decision-making across the provincial network.

Severe pregnancy induced hypertension (PIH) increased from 341 out of 2,357 (14.51%) Before OLOP to 539 out of 2,990 (18.06%) After implementation (OR 1.30, 95% CI 1.12 to 1.51, p<0.001) (Table 2). This rise did not suggest worsening disease incidence but rather reflected strengthened early detection and referral. Under OLOP, district physicians received real-time specialist guidance and standardized criteria for classifying hypertensive emergencies, resulting in earlier identification of severe features that previously

Table 2. Maternal and perinatal outcomes before and after OLOP implementation

Maternal & perinatal outcome	2015 to 2017 (n=2,357), Before; n (%)	2021 to 2023 (n=2,990), After; n (%)	OR (95% CI)	p-value
Severe PIH			1.30 (1.12 to 1.51)	<0.001*
Yes	341 (14.51)	539 (18.06)		
No	2,015 (85.49)	2,450 (81.94)		
APH			6.33 (1.46 to 27.58)	0.009*
Yes	2 (0.13)	16 (0.57)		
No	2,354 (99.87)	2,973 (99.43)		
Preterm labor			0.87 (0.75 to 1.00)	0.051
Yes	425 (18.07)	479 (16.05)		
No	1,931 (81.93)	2,510 (83.95)		
Thick meconium			0.66 (0.41 to 1.06)	0.108
Yes	37 (1.57)	31 (1.04)		
No	2,320 (98.43)	2,959 (98.96)		
Newborn admit NICU			1.16 (1.02 to 1.32)	0.029*
Yes	511 (21.68)	725 (24.25)		
No	1,846 (78.32)	2,265 (75.75)		
Birth asphyxia			0.66 (0.52 to 0.85)	<0.001*
Yes	151 (6.41)	130 (4.35)		
No	2,206 (93.59)	2,860 (95.65)		

PIH=pregnancy induced hypertension; APH=antepartum hemorrhage; NICU=neonatal intensive care unit; OR=odds ratio; CI=confidence interval

* Statistically significant, $p < 0.05$

may have been under-recognized or referred late. The higher referral of severe PIH cases is therefore consistent with improved triage sensitivity and system responsiveness.

APH, although rare, increased from 0.13% to 0.57% after OLOP implementation (OR 6.33, 95% CI 1.46 to 27.58, $p=0.009$) (Table 2). This rise reflected improved recognition rather than a true increase in incidence. Under the standardized OLOP system, district hospitals applied uniform bleeding-assessment criteria, clearer algorithms to differentiate placenta previa versus abruption, and more consistent use of ultrasound to confirm placental location. These changes reduced prior under-recognition of early or mild bleeding episodes. Mandatory immediate referral for any suspected APH supported by real-time specialist consultation also increased case capture at the provincial center. Overall, the rise represented enhanced surveillance accuracy and system responsiveness, not worsening obstetric pathology.

Preterm labor declined from 425 out of 2,357 (18.07%) Before to 479 out of 2,990 (16.05%) After OLOP implementation (OR 0.87, 95% CI 0.75 to 1.00, $p=0.051$) (Table 2). Although borderline for statistical significance, the downward trend was clinically relevant. Earlier identification of threatened preterm labor and timelier referral under

unified OLOP criteria contributed to stabilization prior to delivery. Importantly, this improvement occurred despite a higher-risk maternal profile in the After cohort, suggesting that the reduction reflects system-level strengthening rather than differences in underlying population risk.

Thick meconium decreased from 1.57% to 1.04% (OR 0.66, 95% CI 0.41 to 1.06, $p=0.109$) (Table 2). Although not statistically significant, the downward trend was clinically meaningful and consistent with OLOP's mechanisms. Improved fetal monitoring at district hospitals, standardized FHR-interpretation criteria, and earlier referral for non-reassuring fetal status reduced progression to prolonged fetal distress, a major driver of thick meconium. Centralized oversight enabled real-time specialist input, promoting quicker recognition and escalation. Overall, the trend reflected better intrapartum surveillance and system responsiveness despite the non-significant p -value.

NICU admissions increased from 21.68% to 24.25% (OR 1.16, 95% CI 1.02 to 1.32, $p=0.029$) (Table 2), a rise that reflected system-level improvement rather than worsening neonatal outcomes. Under OLOP, district hospitals applied standardized neonatal triage criteria and more consistent FHR interpretation, leading to earlier identification of infants with borderline Apgar scores

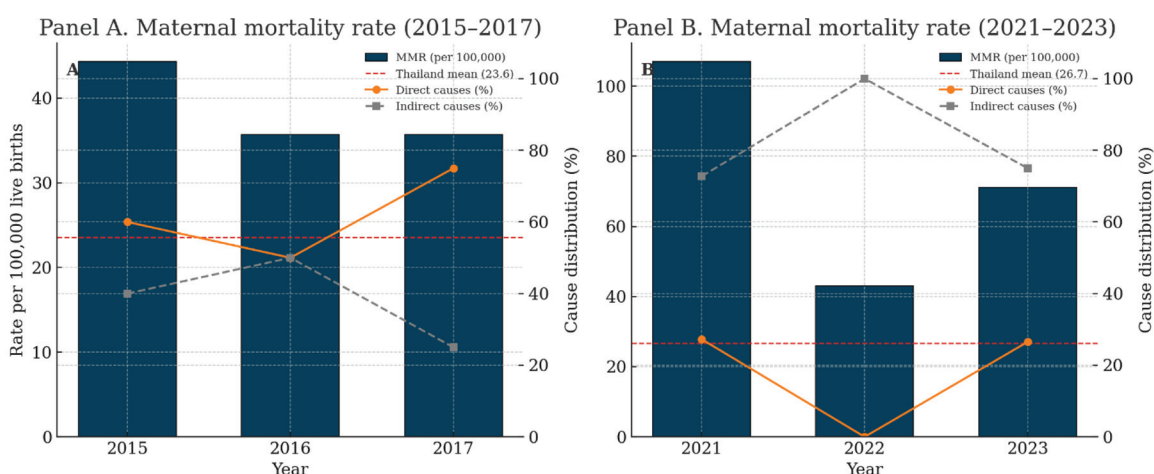


Figure 1. Direct maternal mortality rate (per 100,000 live births) Before (2015 to 2017) and After (2021 to 2023) implementation of the OLOP model in Pattani Province.

or mild respiratory or metabolic concerns. Real-time specialist consultation reduced decision-making variability and appropriately lowered thresholds for NICU transfer. Because the After cohort included more high-risk maternal profiles, increased NICU use represented appropriate escalation of care. Overall, the higher admission rate signals enhanced vigilance and responsiveness across the provincial system.

Birth asphyxia decreased markedly from 6.41% to 4.35% (OR 0.66, 95% CI 0.52 to 0.85, $p < 0.001$) (Table 2), a 34% reduction After OLOP implementation. This improvement reflected strengthened system mechanisms, which included a real-time specialist oversight for district hospitals, standardized cardiotocograph (CTG) interpretation, and clearer thresholds for identifying fetal distress. Earlier recognition of deteriorating fetal oxygenation and more consistent operative-delivery decisions such as vacuum or emergency cesarean, reduced delays that previously contributed to asphyxia. Fast-track referral pathways also enabled high-risk cases to reach specialist care without administrative barriers. Whereas pre-OLOP asphyxia often stemmed from delayed assessment, prolonged second stage, or late detection of obstructed labor, these root causes declined under the centralized model. Collectively, enhanced surveillance, escalation, and timely intervention drove the significant reduction in birth asphyxia.

The mean direct maternal mortality rate per 100,000 live births declined markedly from 61.66 in the Before period to 26.14 in the After period, reflecting substantial improvement in survival despite a higher-risk case mix (Figure 1). RCA showed that most

deaths in the Before period were driven by delayed referral, late severity recognition, and inadequate intrapartum management (Table 3). Following OLOP implementation, preventable intrapartum deaths became uncommon. Instead, the remaining maternal deaths were linked to indirect medical causes that originated long before labor and therefore cannot be fully mitigated within the intrapartum unit alone. These indirect causes highlight a persistent upstream gap, inadequate antenatal detection, incomplete risk stratification, and delayed ANC entry (Table 4). Many women with indirect medical risks first presented late in pregnancy or arrived outside established care pathways, limiting opportunities for timely stabilization or planned delivery. The shift in mortality pattern underscores that while OLOP effectively strengthened intrapartum safety, further reduction in maternal deaths now depended on improving the antenatal platform specifically early ANC initiation, universal risk screening, longitudinal follow-up, and proactive management of chronic medical conditions throughout pregnancy. Notably, the OLOP model achieved a clear and substantial reduction in direct maternal mortality, lowering deaths by more than half compared with the pre-implementation period.

DISCUSSION

This Before and After provincial analysis demonstrates that centralization of intrapartum care significantly improved key outcomes. Notably, birth asphyxia decreased by 34% and direct maternal mortality decreased by more than half, despite a higher proportion of high-risk pregnancies in

Table 3. Root-cause analysis findings for maternal deaths during the Before period (2015 to 2017)

Cause of maternal deaths	2015	2016	2017
Direct causes	<ul style="list-style-type: none">• Postpartum hemorrhage: 2 cases• Severe pre-eclampsia: 1 case RCA: Delayed referral	<ul style="list-style-type: none">• Postpartum hemorrhage: 2 cases• Severe pre-eclampsia: 1 case RCA: Delayed referral	<ul style="list-style-type: none">• Postpartum hemorrhage: 2 cases• Severe pre-eclampsia: 1 case RCA: Delayed referral
Indirect causes	<ul style="list-style-type: none">• Thrombocytopenia: 1 case	<ul style="list-style-type: none">• VSD: 1 case• Seizure: 1 case	<ul style="list-style-type: none">• TTP-HUS: 1 case

RCA=root cause analysis; VSD=ventricular septal defect; TTP-HUS=thrombotic thrombocytopenic purpura-hemolytic uremic syndrome

Table 4. Root-cause analysis findings for maternal deaths during the After period (2021 to 2023)

Cause of maternal deaths	2021	2022	2023
Direct causes	<ul style="list-style-type: none">• Severe pre-eclampsia with eclampsia with abruptio placenta with DFIU with hypovolemic shock with cardiac arrest: 1 case RCA: Delayed entry	–	<ul style="list-style-type: none">• Rupture ectopic pregnancy with intra-abdominal bleeding with hypovolemic shock with cardiac arrest: 1 case RCA: Delayed entry
Indirect causes	<ul style="list-style-type: none">• Sepsis pneumonia: 2 cases• Pulmonary embolism: 1 case• COVID-19: 4 cases	<ul style="list-style-type: none">• COVID-19: 1 case• Myocarditis or cardiomyopathy with heart failure: 1 case• Metastatic choriocarcinoma co-existing pregnancy with intracerebral hemorrhage: 1 case• CA breast with recurrent metastasis: 1 case	<ul style="list-style-type: none">• SLE: 1 case• Unknown cause: 2 cases• Severe sepsis with septic shock with multiple organ failure with DIC: 1 case

DFIU=dead fetus in utero; RCA=root cause analysis; CA=cancer; SLE=systemic lupus erythematosus; DIC=disseminated intravascular coagulation

the After cohort. The shift in RCA patterns from preventable intrapartum causes to indirect medical causes and late presentation parallels findings from previous Thai RCA studies that highlighted referral delay and intrapartum mismanagement as dominant contributors to preventable maternal deaths⁽⁸⁾.

The improvements observed appear driven by system-level redesign. Daily specialist oversight, Tele-Line consultation, and standardized referral pathways enhanced early recognition of obstetric complications, reduced decision-making delays, and minimized practice variability across facilities. These mechanisms align with evidence showing that structured surveillance and guideline-based management reduce preterm labor, birth asphyxia, and meconium aspiration^(2,3,9). The increased detection of severe PIH and APH further suggests improved triage sensitivity rather than deterioration in underlying disease burden^(5,10).

The decrease in preventable maternal deaths is consistent with national analyses linking intrapartum mortality to delayed escalation and inconsistent emergency response⁽¹¹⁾. These findings are concordant with prior reports demonstrating that adherence to standardized obstetric protocols reduces complications such as APH, preterm birth, and meconium aspiration^(2,4,5). Enhanced antenatal and intrapartum monitoring has similarly been associated

with reduced risk of birth asphyxia, consistent with the decline observed in the present study analysis⁽³⁾.

The changes in maternal mortality patterns mirror experiences from other provinces that strengthened referral systems and emergency obstetric networks^(1,8). In addition, earlier research from Pattani identified inadequate ANC and comorbidities such as gestational diabetes as contributors to severe pre-eclamptic complications⁽⁷⁾, reinforcing the need for a province-wide governance model such as OLOP.

Strengths of the present analysis include the use of real-world, province-wide data collected over seven years, incorporation of RCA findings to contextualize maternal deaths, and evaluation of a system-wide intervention deployed across all facilities. These strengths reinforce broader national evidence demonstrating that many maternal deaths in Thailand are preventable^(12,13).

Limitations include the Before and After design, evolving NICU admission thresholds, and absence of multivariate adjustment. However, the fact that the After cohort had a higher baseline risk profile strengthens confidence that the improvements are attributable to system-level changes rather than differences in case mix. The effectiveness of province-wide network service models in reducing preventable maternal mortality has been previously

demonstrated, supporting the scalability of the OLOP approach⁽¹³⁾.

CONCLUSION

Implementation of the OLOP model Thailand's first province-wide centralization of intrapartum services was associated with earlier detection of high-risk conditions, timelier referral, and significant improvements in neonatal and maternal outcomes. Despite a more complex referral population, the system achieved a marked reduction in birth asphyxia and greater than a 50% decline in direct maternal mortality. These findings support specialist-led, teleconsultation-supported centralization as an effective, scalable strategy to strengthen intrapartum safety in resource-limited provincial settings.

WHAT IS ALREADY KNOWN ABOUT THIS TOPIC?

- Maternal near-miss events and adverse perinatal outcomes often arise in health systems with fragmented intrapartum surveillance and referral pathways.
- International evidence shows that decentralized labor rooms without specialist oversight face higher rates of misdiagnosis, delayed escalation, and inconsistent adherence to obstetric guidelines.
- WHO and FIGO highlight that improving maternal outcomes particularly in disadvantaged populations require integrated referral systems and timely specialist involvement.
- Despite this, province-wide obstetric centralization models remain uncommon globally, and prior to this study Thailand had no documented example of a fully integrated, specialist-led provincial intrapartum system.

WHAT DOES THIS STUDY ADD?

- This is the first provincial evidence from Thailand demonstrating that a fully centralized intrapartum service model is feasible and effective.
- Integration of teleconsultation, unified referral pathways, and standardized obstetric guidelines improved intrapartum safety.
- High-risk pregnancies were identified earlier and referred more rapidly, despite increasing case complexity.
- Birth asphyxia and direct maternal mortality declined, while NICU access for compromised newborns improved.
- The OLOP model offers a scalable provincial framework for strengthening maternal and perinatal care in similar settings.

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AUTHORS' CONTRIBUTIONS

RJ: Conceptualization, study design, data analysis and interpretation, manuscript drafting, critical revision of all sections, and final approval of the submitted version.

TC: Data acquisition, data preparation and verification, assistance in dataset organization, and review of the final manuscript.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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