
OBSTETRICS

Analysis of Trends, Causes, and Risk Factors of Maternal Mortality in Sakon Nakhon Hospital: A 22-year retrospective study (fiscal years 2003 to 2024)

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ABSTRACT

Objectives: To analyze the trends, causes, and contributing risk factors of maternal mortality at Sakon Nakhon Hospital over a 22-year period.

Materials and Methods: A retrospective review was conducted utilizing hospital records of maternal deaths. Data sources included inpatient medical charts, antenatal care (ANC) records, and documentation from maternal mortality review conferences. The variables collected encompassed maternal demographic characteristics, gravidity, parity, number of ANC visits, gestational age at initiation of ANC and at the time of death, location of ANC services, pre-existing comorbidities, causes and timing of maternal death, and assessments based on the Three Delays Model. Additionally, to evaluate the impact of healthcare system changes, maternal mortality rates and associated characteristics were compared before and after the implementation of the 2020 health service reform.

Results: Between fiscal years 2003 and 2024, a total of 87,041 live births and 83 maternal deaths were recorded at Sakon Nakhon Hospital, yielding an overall maternal mortality rate (MMR) of 95.36 per 100,000 live births. A temporal trend analysis revealed a decline in MMR from 106.77 per 100,000 live births prior to 2016 to 56.17 during the period 2017–2019. However, the MMR subsequently increased to 82.02 in the period 2020–2024 after the health service reform. Among the maternal death cases, only 28% of women received at least four quality antenatal care (ANC) visits, while another 28% had no ANC visits at all. Common comorbidities identified included extremes of maternal age (adolescents and women of advanced maternal age) and diabetes mellitus. Notably, 12% of the cases had no documented comorbidities. A shift in the leading causes of maternal death was observed over time, with obstetric hemorrhage predominating prior to 2016, and non-obstetric medical complications emerging as the leading cause in subsequent years. The Three Delays Model Analysis showed that the majority 47% had delay in decision to seek care while another 38% had delay in reaching health care and 15% had delay in receiving quality care.

Conclusion: The MMR declined in the period 2017–2019 and subsequently increased in the period 2020–2024 after the health service reform. Enhancing early access to and the quality of antenatal care, conducting systematic evaluations for maternal comorbidities, and ensuring timely referral to appropriate levels of care are critical strategies for reducing maternal mortality. The observed changes in maternal death patterns following 2020 suggest that the decentralization policy implemented that year may have had implications for the effectiveness

of the obstetric referral system. Further investigation is warranted to evaluate the policy's impact on maternal health outcomes.

Keywords: maternal mortality, MMR, Sakon Nakhon Hospital

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การวิเคราะห์แนวโน้ม สาเหตุ และปัจจัยเสี่ยงของการเสียชีวิตมารดาในโรงพยาบาล สกลนคร: การศึกษาย้อนหลัง 22 ปี (ปีงบประมาณ พ.ศ. 2546–2567)

สมใจ อุดมพงศ์ลักขณา

บทคัดย่อ

วัตถุประสงค์: เพื่อประเมินแนวโน้มและสาเหตุของการเสียชีวิตของมารดาในโรงพยาบาลสกลนคร

วัสดุและวิธีการ: ทบทวนเวชระเบียนของหญิงตั้งครรภ์ที่เสียชีวิตในโรงพยาบาล บันทึกการฝากครรภ์ และรายงานการประชุมทบทวนการเสียชีวิตของสตรีตั้งครรภ์แต่ละรายรวบรวมข้อมูลประกอบด้วยลักษณะเฉพาะของผู้ป่วยและสาเหตุการเสียชีวิต

ผลการศึกษา: จากจำนวนการเกิดมีชีพ 87,041 รายในโรงพยาบาลสกลนคร ระหว่างปี พ.ศ. 2546-2567 มีมารดาเสียชีวิต 83 ราย (95.36 ต่อการเกิดมีชีพ 100,000 ราย) อัตราการตายของสตรีตั้งครรภ์ ในแต่ละปีสูงกว่า 17 ต่อการเกิดมีชีพ 100,000 ราย มีเพียงปี พ.ศ. 2564 เท่านั้นที่ อัตราตายของสตรีตั้งครรภ์เป็นศูนย์ กระบวนการดำเนินงานที่สำคัญที่ก่อให้เกิดความสำเร็จคือการแก้ไขสาเหตุการเสียชีวิตของมารดาที่ป้องกันได้ เช่น การทำแท้งผิดกฎหมายและกลุ่มสาเหตุจากโรคทางศัลยกรรม การพัฒนาเครือข่ายการดูแลสุขภาพและการพัฒนาศักยภาพของบุคลากรมีความสำคัญอย่างยิ่งต่อการลดการเสียชีวิตของมารดา ประการสุดท้าย ในปัจจุบัน สาเหตุสำคัญของการเสียชีวิตของสตรีตั้งครรภ์มีแนวโน้มเปลี่ยนจากสาเหตุทางสูติศาสตร์เป็นสาเหตุทางอายุรกรรมเพิ่มขึ้น ดังนั้นโรคประจำตัวของหญิงตั้งครรภ์ทุกคนจึงจำเป็นต้องได้รับการค้นหาและตรวจวินิจฉัยอย่างสม่ำเสมอ

สรุป: อัตราการตายของสตรีตั้งครรภ์ลดลงในช่วงปี พ.ศ.2550-2552 และกลับมาเพิ่มขึ้นในช่วงปี พ.ศ. 2563-2567 การเสียชีวิตของสตรีตั้งครรภ์ ส่วนใหญ่สามารถป้องกันและจัดการได้ หากบุคลากรทางการแพทย์ทุกคนตระหนักและคอยเฝ้าระวัง พิจารณาดูแลรักษาสตรีตั้งครรภ์อย่างเหมาะสม ในสถานที่ที่มีความพร้อมและมีศักยภาพเพียงพอ ในเวลาที่เหมาะสม จึงเป็นสิ่งที่ควรให้ความสำคัญ

คำสำคัญ: อัตราการเสียชีวิตของมารดา, โรงพยาบาลสกลนคร

Introduction

The maternal mortality rate (MMR) is a key indicator of maternal health and healthcare system performance. Maternal deaths represent not only a tragic loss for families but also a public health concern that may lead to legal consequences. According World Health Organization, there were 88 maternal deaths in 2023 in Thailand, contributing to the MMR of 34 per 100,000 live births⁽¹⁾. In line with the United Nations Sustainable Development Goals (SDGs), Target 3.1 aims to reduce the global MMR to fewer than 70 per 100,000 live births by 2030⁽²⁾. Thailand has set a national target of 17 per 100,000 live births.

Sakon Nakhon Hospital, a regional referral center in the upper northeastern region of Thailand, has consistently reported maternal mortality rates exceeding both national and global targets. Globally, the leading causes of maternal mortality include obstetric hemorrhage, hypertensive disorders, sepsis, obstructed labor, and complications from unsafe abortion^(3, 4). In Thailand, leading causes include postpartum hemorrhage, hypertensive disorders, sepsis, and medical comorbidities such as cardiovascular disease and diabetes mellitus. These findings align with national studies^(5, 6).

According to literature, contributors of maternal mortality include: (1) social determinants, such as socioeconomic status, maternal education, exposure to sources of hyperinformation and disinformation, living in rural area, (2) individual factors, such as extreme maternal age, high parity, marital status, absence of or low partner involvement in antenatal care and intrapartum care, and (3) health services and health education, such as low knowledge of danger signs, absence of agency and autonomy for health-care seeking, poor access to health services, and substandard care⁽⁷⁾. In response, this study aimed to compile and analyze maternal mortality data collected over the past 22 fiscal years, in order to identify trends, causes, and contributing factors. The ultimate goal is to use this information for strategic planning to prevent

future maternal deaths⁽⁸⁾.

Materials and Methods

This study employed retrospective design. The study population comprised all pregnant women who died at Sakon Nakhon Hospital between fiscal years 2003 and 2024. Data were obtained through a comprehensive review of hospital medical records, antenatal care documentation, and maternal mortality review conferences. Information collected included age, body mass index, gravidity, parity, number of antenatal care (ANC) visits, gestational age at initiation of ANC and at the time of death, location of ANC services, pre-existing comorbidities, causes and timing of maternal death, and assessments based on the Three Delays Model. This study has been reviewed and approved by the Board of Ethical Committee in Human Research, COA1 No.015/2568.

Results

Over the 22-year study period, there were 87,041 live births and 83 maternal deaths, resulting in an average maternal mortality rate of 95.36 per 100,000 live births. In fiscal year 2020, the province's maternal health network received formal certification. No maternal deaths were reported in fiscal year 2021. However, maternal mortality increased again in fiscal year 2022. One significant contributing factor was the national decentralization policy enacted in 2020, which transferred administrative control of Subdistrict Health Promoting Hospitals from the Ministry of Public Health to the Ministry of Interior. This restructuring led to diminished oversight, disrupted referral pathways, and compromised the quality of primary maternal healthcare, resulting in preventable delays and inadequate early interventions. (Fig. 1.)

A total of 83 maternal deaths were analyzed over the 22-year study period. The mean maternal age was 31 years. The majority of the women ($n = 79$, 95%) were married. With respect to health

coverage, the Universal Coverage Scheme accounted for 73% of cases, followed by the Social Security Scheme (16%), the Government Officials' Scheme (5%), and other schemes (5%).

Occupational data revealed that 29 women (35%) were farmers, and 18 women (22%) were employed as laborers or in other forms of manual

work. The mean body mass index was 26.25 kg/m². Regarding parity, 27 women (33%) were primigravida, while 4 women (5%) were classified as grand multiparous. With respect to comorbidities, 31 women (37%) were considered advanced maternal age, 10 women (12%) had diabetes, and 8 women (9%) were teenagers.

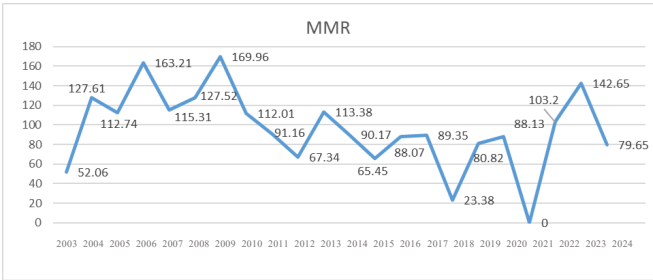


Fig. 1. Maternal mortality rate, fiscal years 2003–2024.

Antenatal care (ANC) was received by 59 women (71%), with an average of 7 ANC visits. Of these, 31 cases (52%) initiated ANC before 12 weeks' gestation. However, based on medical record review, 35 of the ANC recipients (59%) did not meet the quality standards defined by national ANC guidelines.

Gestational age at the time of maternal death was categorized as follows: miscarriage (< 20 weeks gestation) accounted for 12 cases (15.66%) with a mean gestational age of 13 weeks; preterm deliveries (< 37 weeks) accounted for 37 cases (44.58%) with a mean gestational age of 30 weeks; and term deliveries (≥ 37 weeks) accounted for 34 cases (40.96%) with a mean gestational age of 39 weeks.

The causes of maternal death were classified into four major categories: obstetric causes, medical causes, surgical causes, and abortion-related causes (Fig. 2.) (Table 1). The most common individual cause of death was postpartum hemorrhage, responsible for 19 cases (22.89%), followed by cardiovascular disease (n = 10, 12.05%). When grouped, medical causes accounted for the highest proportion (n = 41, 49.40%),

followed by obstetric causes (n = 28, 33.73%), abortion-related causes (n = 9, 10.84%), and surgical causes (n = 5, 6.02%).

Notably, the last abortion-related maternal death was recorded in fiscal year 2017. The decline in abortion-related mortality is attributed to multiple factors, including the strengthening of the Provincial Maternal and Child Health (MCH) Committee, the successful implementation of the Provincial Network Certification (PNC), and Sakon Nakhon Hospital's integration into the Referral Safe Abortion (RSA) network. These efforts expanded access to safe abortion services, further bolstered by the passage of national legislation in 2021 that decriminalized abortion under specified conditions, effectively eliminating maternal deaths due to unsafe abortion thereafter.

Analysis of the initial point of care revealed that 33 maternal deaths (39.76%) involved women who first sought treatment at community hospitals within Sakon Nakhon Province, while 24 cases (28.92%) were initially treated at Sakon Nakhon Hospital (Table 1).

4 Group of Maternal Death in Sakon Nakhon Hospital From 2003 To 2024



Fig. 2. Mortality among pregnant women reported into 4 clinical groups.

Table 1. 4 Groups of diagnostic cause of maternal death in Sakon Nakhon Hospital from 2003 to 2024, categorized according to initial point of care

	Obstetric			Criminal Abortion	Medical														Surgical			total
	PPH	PIH	APH		SLE	Pneumonia	Heart	HIV	Sepsis	Stroke	Pulmonary edema	Convulsion	Diarrhea	Embolism	Fatty liver	Hematologic disease	Meningoencephalitis	CA breast	Accident	Peritonitis	Gut obstruction	
Walk in	3	2	0	2	0	2	4	1	4	0	0	0	2	1	1	0	1	0	0	0	1	24
(%)	16	29		22		67	40	33	57				67	20	100		100				50	
Refer in node	2	0	2	1	1	0	1	1	1	1	0	0	1	1	0	0	0	1	1	0	0	14
(%)	11	14	50	11	33		10	33	14	100			33	20				100	50			
Refer in province	9	1	1	6	1	1	2	1	2	0	0	1	0	3	0	1	0	0	0	1	1	33
(%)	47	43	50	67	33	33	20	33	29			100		60		100				100	50	
Referring to the outside province	5	1	0	0	1	0	3	0	0	0	1	0	0	0	0	0	0	0	1	0	0	12
(%)	26	14			33		30				100								50			
All group	19	7	2	9	3	3	10	3	7	1	1	1	3	5	1	1	1	1	2	1	2	83

When categorizing maternal deaths using the International Classification of Diseases - Maternal Mortality (ICD-MM) system⁽⁹⁾, the top three leading causes were identified as follows (Table 2): 1. Pregnancy-related infections, 2. Non-obstetric complications (e.g., pre-existing or newly developed medical conditions not directly related to pregnancy), and 3. Obstetric hemorrhage. Notably, obstetric hemorrhage, which had

historically been the leading cause of maternal death at Sakon Nakhon Hospital, has declined in prevalence and is now the third most common cause. This shift reflects improved clinical management of postpartum bleeding, greater availability of skilled personnel, and strengthened emergency obstetric care systems. On contrary, the emerging cause of maternal death was non-obstetric complications.

Table 2. Groups of underlying causes of death during pregnancy: International classification of diseases - maternal mortality.

Group name	cases	%
1. Pregnancies with abortive outcome	9	10.7
2. Hypertensive disorders in pregnancy	7	8.4
3. Obstetric hemorrhage	21	25.4
4. Pregnancy-related infection	17	20.5
5. Other obstetric complications	6	7.2
6. Unanticipated complications of management	0	0
7. Non obstetric complications	21	25.4
8. Unknown/Undetermined	0	0
9. Coincident causes	2	2.4

Using the R8 Model Risk Assessment Guidelines⁽¹⁰⁾, which stratify maternal risk based on local context, healthcare readiness, and system capacity, women were categorized into four risk levels: very low, low, high, and very high (Table 3). 24 women (28.92%) who were classified as high-risk

and very high-risk pregnancies initially received care at community hospitals before being referred to Sakon Nakhon Hospital. This highlights a critical point of intervention where early recognition and timely referral may have prevented adverse outcomes.

Table 3. Risk stratification of 83 deceased pregnant women.

	Very low risk	Low risk	High risk	Very High risk	Total
Walk in	5	9	8	1	23
(%)	21.7	39.1	34.8	4.3	100
Refer (in node)	3	4	4	4	15
(%)	20	26.7	26.7	26.7	100
Refer (in province)	8	15	6	5	34
(%)	23.5	44.2	17.6	14.7	100
Refer (outside province)	2	4	4	1	11
(%)	18.1	36.4	36.4	9.1	100
Total	18	32	22	11	83

The inevitable causes of death occurred during: antepartum (before labor) in 40 cases (48.12%), intrapartum (during labor) in 5 cases (6.02%), and postpartum (after delivery) in 38 cases (45.78%). These contributed to deaths during: antepartum: 24 cases (28.92%), intrapartum: 3 cases (3.61%), and postpartum: 56 cases (67.47%), accordingly. The latter figures suggest that most maternal deaths occurred in the postpartum period, underscoring the need for

intensive monitoring and continued care during the postnatal phase.

Among the 60 referred cases, referral performance was assessed using the Rapid Obstetric Emergency Response (ROBER) criteria established by Health Region 8. The protocol determines the referral time based on the assessment of the obstetrician during the first 20 minutes. Experts were immediately informed of the second period (30

minutes)—the time from discharge from the original hospital—and the third period (60 minutes)—which was the time for critical procedures. All 60 referred women exceeded the recommended referral time limits, representing a 100% failure rate in timely referral. These delays contributed significantly to maternal deaths and reflect systemic gaps in emergency obstetric care coordination⁽¹¹⁾.

The condition of the 83 pregnant women upon arrival at Sakon Nakhon Hospital was divided into three groups based on the emergency assessment: good (ESI 4-5), fair (ESI 3), and poor (ESI 1-2). Upon arrival at Sakon Nakhon Hospital, five women (6.02%) were in the good category, 22 (26.5%) were in the fair category, and 56 (67.47%) were in the poor category. This indicates a delay in referral, and the women's condition was already severe and at high risk of death upon arrival at Sakon Nakhon Hospital. To reduce the mortality rate of pregnant women, it is imperative that they receive care as quickly as possible and while

their condition is still mild⁽¹²⁾.

Delay in accessing services, analyzed according to the 3 delay model⁽¹³⁾ (in some cases, more than 1 cause of delay was found), it was found that the group that was caused by delay in deciding to seek care, which is mainly due to the lack of awareness, geographical isolation, or fear of legal consequences especially in abortion cases. (Table 4) These were frequently observed in cases where the woman self-presented to the hospital, often with advanced or severe symptoms. Delay in receiving quality care, which is a delay caused by various factors of personnel, service units, and service systems, including delay in reaching health facility care, which is a delay in the referral system, such as late referral decision, refusal to accept a referral from a service unit with higher potential and better readiness, was found in a similar number for all causes. The problem was found in the service unit located in Sakon Nakhon Province, which had the longest travel distance.

Table 4. Assessment due to three delay model.

	Delay in decision to seek care	Delay in reaching health facility care	Delay in receiving quality care
Walk in	13	0	9
Refer (in node)	7	6	7
Refer (in province)	16	25	19
Refer (outside province)	3	9	5
Total	39	40	40

Among the 83 maternal death cases analyzed, birth outcomes were as follows: miscarriage (< 20 weeks' gestation) occurred in 12 cases (14.46%), normal vaginal delivery in 31 cases (37.35%), vacuum-assisted delivery in 6 cases (7.23%), cesarean section in 22 cases (26.51%), and undelivered pregnancies in 12 cases (14.46%).

Of the neonates with recorded sex, 31 (52.54%) were male and 28 (47.46%) were female. The average birth weight was 2,357 grams. The mean Apgar score at 1 minute was 6, and at 5 minutes was 7. Neonatal outcomes included 24

cases (40.68%) of live births with good condition, 10 cases (16.95%) of severe birth asphyxia, and 13 cases (22.03%) of fetal death (stillbirth or intrauterine demise). The remaining 12 cases (20.34%) were categorized under other outcomes, including congenital anomalies or incomplete documentation.

The mean length of hospital stay related to the index pregnancy was 3 days. The average hospital cost per case was 50,355.98 Thai Baht. In 5 cases, the total cost exceeded 100,000 Baht, with the highest recorded case reaching 370,570 Baht.

Discussion

The MMR at Sakon Nakhon Hospital averaged 95.36 per 100,000 live births—nearly three times higher than the national average of 34 per 100,000 live births⁽¹⁾. This elevated rate reflects a complex interplay of individual, clinical, and systemic factors. Key risk factors identified in this study included extreme maternal ages (both adolescent and advanced maternal age pregnancies), pre-existing diabetes mellitus, and delays in both decision-making to seek care (Delay 1) and in accessing appropriate healthcare facilities (Delay 2), as defined by the Three Delays Model.

A significant trend observed over the 22-year study period was the shift in the leading cause of maternal death from direct obstetric complications, particularly postpartum hemorrhage, to indirect causes such as medical and surgical comorbidities. This transition mirrors findings reported by Charoenweerakul et al at Chiang Mai Hospital⁽¹⁴⁾, underscoring the increasing contribution of non-obstetric conditions to maternal mortality. Consequently, comprehensive comorbidity evaluation and risk stratification during early pregnancy are essential, as they facilitate timely referral to higher levels of care and improve maternal outcomes.

Importantly, the incidence of maternal deaths due to unsafe abortion has declined to zero since 2017, attributable to the strengthening of the RSA network and the introduction of legal and policy reforms that expanded access to safe abortion services. This achievement highlights the value of coordinated public health efforts in eliminating preventable causes of maternal mortality.

At the system level, the PNC has proven instrumental in establishing a comprehensive, risk-stratified maternal care network. This model integrates services across three designated zones, each managed by an obstetrician, and supported by general surgeons who contribute to the management of obstetric and surgical emergencies. Over the past nine years, this zonal structure has significantly

reduced deaths due to surgical complications by enhancing access to appropriate specialist care.

Despite these improvements, challenges remain—particularly in addressing deaths related to internal medical conditions, which have now become the most frequent cause of maternal mortality. A key gap identified is the shortage of internal medicine practitioners within the zonal care system. In response, policy adjustments could include mandating at least one general medicine consultation for all pregnant women during the first trimester. This would help in the early detection and management of chronic conditions that increase risk in late pregnancy.

Additionally, most maternal deaths occurred among women insured under the Universal Coverage Scheme (UCS), which does not include annual health screenings. Expanding preconception care—particularly targeting women with known medical conditions—should be a national priority. Campaigns promoting routine health checks and chronic disease management before pregnancy may significantly reduce preventable maternal deaths.

The implementation of a unified care model—“One Province, One Hospital”—may further enhance the effectiveness of the maternal care system by consolidating resources, streamlining referrals, and minimizing inter-institutional conflicts. Such integration would ensure that high-risk pregnant women are transferred to adequately equipped care units earlier, before experiencing critical deterioration. Currently, 67.47% of maternal deaths occur when the patient’s Emergency Severity Index (ESI) has already dropped to level 1 or 2, indicating critical condition upon arrival. Beyond clinical implications, reducing maternal mortality also has profound social and economic benefits. Preventing maternal deaths helps avoid long-term outcomes such as orphaned infants and children with severe birth asphyxia or cerebral palsy—conditions that place a lasting burden on families and the healthcare system. Additionally, maternal death imposes a significant financial toll, with hospital costs exceeding 300,000 Thai Baht in some cases.

In comparison, similar findings have been reported in international and Thai contexts. A recent study in United States⁽¹⁵⁾ emphasized the impact of healthcare system reforms on maternal outcomes, while two studies in Thailand^(5, 6) identified preventable risk factors similar to those observed in Sakon Nakhon. These alignments reinforce the need for sustained system-level monitoring and resource integration.

Conclusion

This 22-year retrospective study demonstrated that while Sakon Nakhon Hospital achieved a significant reduction in the MMR during the 2017–2019 period, the subsequent rise observed from 2020 to 2024 highlights emerging systemic challenges. The resurgence of maternal deaths coincides with the 2020 health service decentralization policy, suggesting that structural changes may have inadvertently compromised the effectiveness of the obstetric referral system and contributed to delays in reaching healthcare facilities. Furthermore, the epidemiological shift from obstetric hemorrhage to non-obstetric medical complications—compounded by the finding that a significant proportion of women received insufficient or no antenatal care—underscores the need for rigorous comorbidity screening and management. To reverse current trends, health strategies must prioritize addressing the barriers to decision-making and access (Delays 1 and 2), enhancing the quality of early antenatal care, and re-evaluating the impact of the 2020 reform to restore timely access to comprehensive emergency obstetric services.

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Potential conflicts of interest

The author declares no conflicts of interest.

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