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Research Article

Causes of death, three delays, and factors associated with Delay 1 among maternal deaths in Myanmar: The maternal death surveillance in 2019



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ABSTRACT

Objective: The maternal mortality ratio (MMR) in Myanmar was the highest in Southeast Asia in 2017. The Three Delay Model is used to evaluate delays that contribute to maternal deaths. This study aims to identify MMR, causes of death, the three delays related to maternal deaths, and the factors associated with Delay 1, which is the time of delay in deciding to seek health care (from the start of the woman's illness to the time when the problem is recognized to be requiring care), in Myanmar. *Study design:* A cross-sectional study.

Participant: This study included 934 cases of maternal deaths reported from all states and regions throughout Myanmar in 2019 that were not caused by accidents and injuries.

Materials and methods: Socio-demographic factors, obstetrical factors, information about deaths, and assessment of delays were obtained from the Maternal Death Surveillance and Response System, the database of maternal deaths. Distribution of maternal deaths by states and regions, causes of maternal death, and types of delay that contributed to maternal deaths were descriptively summarized. Logistic regression analysis was performed to identify factors associated with Delay 1 among 567 maternal deaths without any missing data and unknown information on delays.

Findings: In 2019, the MMR was 106 (95% confidence interval, 99–112) per 100,000 live births. Of the 934 maternal deaths, 80.5% of deaths had at least one delay, and Delay 1 was the major delay (72.9%). Eclampsia/pre-eclampsia (21.6%), postpartum hemorrhage (18.2%), and abortion-related complications (13.2%) were the major causes of maternal death. The husband's low education, low household income, unplanned pregnancy, and no antenatal care were associated with Delay 1.

Key conclusions and implication for practice: The MMR was lower in 2019 than that in 2017 but remained high. Moreover, we demonstrate that most maternal deaths had at least one delay, mostly Delay 1. To prevent maternal deaths caused by Delay 1, the family planning should be promoted to prevent unplanned pregnancies. Educational training for healthcare providers who deliver antenatal care should be strengthened. Furthermore, education on the danger signs of pregnancy and during childbirth should be provided not only to pregnant women and their husbands in communities at health facilities.

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Introduction

Globally, approximately 295,000 women died during pregnancy and childbirth in 2017 (World Health Organization, 2019). Particularly, 86% of global maternal deaths occurred in Sub-Saharan Africa and South Asia regions (World Health Organization, 2019). The maternal mortality ratio (MMR) in 2015 ranged from 12 in developed regions to 546 in Sub-Saharan Africa (Alkema et al., 2016). Most maternal deaths are preventable if appropriate medical treatment is provided on time (Wilmoth et al., 2012). To achieve the global target of Sustainable Development Goals (SDG) by 2030, the MMR needs to be reduced by at least 7.5% of the annual rate, in each year (United Nations Secretariat, 2017). Integrated care for high-risk pregnant women and universal coverage, including comprehensive emergency obstetric care, strengthening the health system, and social equity, is necessary for ending preventable maternal deaths (Tuncalp et al., 2015; Souza et al., 2013). To decrease the

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MMR, it is also important to improve access to and use of health facilities (El Arifeen et al., 2014).

The Three Delays Model was proposed to evaluate delays that contribute to maternal deaths (Thaddeus and Maine, 1994). Delay 1 is the time of delay in deciding to seek health care (the time from the start of the woman's illness to the time when the problem is recognized to be requiring care). Lack of information and inadequate knowledge about danger signs during pregnancy and labor, the level of health literacy of the mother or the caregiver, the social hierarchy that restricts women from seeking health care, and poverty contribute to Delay 1 (Thaddeus and Maine, 1994; Ministry of Health, Myanmar, 2020). Delay 2 is the time of delay in reaching an adequate health facility (the time from acknowledging the problem to the time of reaching a health facility). Geographical remoteness, including poor road infrastructure, limited or lack of public transportation, time and opportunity costs, and security concerns, contribute to Delay 2 (Thaddeus and Maine, 1994; Ministry of Health, Myanmar, 2020). Delay 3 is the time of delay in receiving adequate health care at a health facility (the time of arrival at a health facility to the time that the required treatment was received). Lack of timely recognition and referral of complicated cases leading to the delayed time of arrival at a higher-level facility, anesthetic accidents, inadequacy of supplies, equipment, trained personnel, and the competence of health care providers are the relevant factors of Delay 3 (Thaddeus and Maine, 1994; Ministry of Health, Myanmar, 2020).

In Myanmar, the MMR was 335 deaths per 100,000 live births (LB) in 1998, and 282 deaths per 100,000 LB in 2014 (Ministry of Immigration and Population, Myanmar, 2015). In 2017, the MMR in Myanmar was 250 per 100,000 LB, which was the highest in Southeast Asia (World Health Organization, 2019). To eliminate preventable maternal deaths in Myanmar, the Maternal and Reproductive Health Division, Department of Public Health, Ministry of Health (MOH) introduced the Maternal Death Review (MDR) System as a pilot project in 2005, which was expanded nationwide. Lack of information on the population at risk, misclassification of the cause of death, and under-reporting of maternal deaths that occurred in remote areas are the weaknesses of the MDR system (Ministry of Health, Myanmar, 2014). Response plans could not be executed due to poor financial support and insufficient human resources to conduct the review meetings (Millimouno et al., 2019).

In 2017, the Maternal Death Surveillance and Response (MDSR) System was rolled out across all states and regions in Myanmar. The MDSR system emphasized the surveillance, which needed more accurate and complete data on the numbers of maternal deaths, and the response involved formulating and implementing targeted recommendations (Ministry of Health, Myanmar, 2019). However, the MDSR 2019 data have not been analyzed, and it is important to obtain information related to maternal deaths in 2019 to provide further evidence-based information for implementing activities to reduce preventable maternal deaths in Myanmar. Therefore, by analyzing the MDSR data in 2019, this study aims to identify MMR, causes of death, the three delays related to maternal deaths, and the factors associated with Delay 1.

Materials and methods

Study participants

This study included all reported cases of maternal deaths (deaths during pregnancy, during childbirth, and within 42 days after childbirth) from all places in Myanmar from January 1 to December 31, 2019. Maternal deaths due to accidents and injuries were excluded from the study. A total of 935 maternal deaths were reported in 2019. One case of death due to accident was excluded. In the end, 934 cases were analyzed in this study.

Data collection methods

When a maternal death occurred, a midwife (MW) or a medical doctor of the hospital within the area of the maternal death had to notify the respective state or regional health department and the central MDSR team within 24 hours from the maternal death using the standardized notification form. In the MDSR system, data on maternal deaths were collected by the MDSR team at the township (sub-division of a district) level using the standardized maternal death investigation form. The township-level MDSR team conducted a field investigation (verbal autopsy) at the place of maternal death and collected data within 21 days of the maternal death. The collected data were reported to the respective state or regional health department. All the maternal death data from 17 states and regions were sent to the central MDSR team of the MOH.

Reported data included (1) socio-demographic characteristics of the deceased mother, her husband, and household, (2) obstetric history and medical history, (3) antenatal care (ANC) status, (4) childbirth history, (5) causes of maternal death, (6) place (health facility, home, or on the way to a health facility) and the time of death (during pregnancy, during childbirth, or postnatal), (7) careseeking history before death, (8) types of delay (Delay 1 for delay in seeking care, Delay 2 for delay in reaching care, and Delay 3 for delay in receiving care), and (9) view and comments from the investigation team.

MMR

The reporting numbers of LB in all states and regions were obtained from the health management information system (HMIS), MOH, Myanmar, as MDSR system was not included LB information. The MMR was estimated as the number of maternal deaths per 100,000 LB with 95% confidence intervals (CIs).

Types of delay

Types of delay were decided by the state and regional MDSR review committees. They reviewed detailed information obtained from verbal autopsy (using the community field investigation form), hospital maternal death investigation forms, a maternal and child health record book, all investigation results, treatment records, referral forms, and the post-mortem examination record form for each maternal death within their respective state or region. To explore Delay 1, they obtained information based on the place of childbirth, place of death, duration from the onset of suffering signs and symptoms to the time of deciding to seek health service, the reason for the delay in or not seeking health service, barriers to seeking health service, and their ways of solving these problems. For Delay 2, they obtained information based on the history of the journey to the health care facility, time to reach the health facility, transportation, and other barriers to reaching the facility on time. For Delay 3, they obtained information by assessing the time between the arrival at the health facility and receiving the treatment, types of illness, and treatments at the facility.

Correlation of characteristics of maternal deaths and types of delay

After excluding 55 deaths due to unknown information about delays and 312 deaths due to missing data on variables included in the analyses, 567 maternal deaths were included for the analysis of characteristics of maternal deaths and factors associated with Delay 1 in this study. The collected data were coded and analyzed using the statistical package for social science (SPSS) software version 28. Descriptive analysis was used to describe the frequency and percentage distribution of the data and logistic regression was

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ne	type	of	delays	and	the	time	of	maternal	deaths	(N =	934)	Į.
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	Total	Time of Death				
Types of delay	(N = 934)	Antenatal	Childbirth	Postnatal		
	N (%)	(n = 356) n (%)	(n = 82) n (%)	(<i>n</i> = 496) n (%)		
No delay	127 (13.6)	48 (13.5)	7 (8.5)	72 (14.5)		
Delay 1	430 (46.0)	185 (52.0)	28 (34.1)	217 (43.8)		
Delay 2	8 (0.9)	3 (0.8)	2 (2.4)	3 (0.6)		
Delay 3	55 (5.9)	9 (2.5)	11 (13.4)	35 (7.1)		
Delay $1 + 2$	186 (19.9)	71 (19.9)	23 (28.0)	92 (18.5)		
Delay $1 + 3$	31 (3.3)	9 (2.5)	5 (6.1)	17 (3.4)		
Delay $2 + 3$	8 (0.9)	1 (0.3)	0 (0.0)	7 (1.4)		
Delay $1 + 2 + 3$	34 (3.6)	12 (3.4)	5 (6.1)	17 (3.4)		
Unknown	55 (5.9)	18 (5.1)	1 (1.2)	36 (7.3)		

employed to examine the relationship between dependent and independent variables. In multivariate logistic regression analysis, independent variables involved in Delay 1 were age, residence, ethnicity, education, occupation, education of husband, occupation of husband, family monthly income, gravida, parity, history of abortion, planned pregnancy, and ANC visits. Statistical significance was set at P < 0.05.

Ethical approval

The approval to use the maternal deaths data in 2019 was given by the director of the Maternal and Reproductive Health Division, Department of Public Health, MOH. Data were kept confidential and anonymized. Since this study used anonymous data from the routine collection of the MOH, ethical approval was waived.

Results

A total of 934 reported maternal deaths were analyzed in this study. The nationwide MMR (per 100,000 LB) was 106 (95% CI 99–112). According to the state and regional distribution of the MMR shown in Fig. 1, the Chin State had the highest MMR (167; 95% CI 104–239), followed by the Rakhine State (147; 95% CI 117–179) and the Ayeyarwaddy Region (132; 95% CI 110–155). The Shan (East) State had the lowest MMR, which was 65 (95% CI 19–121).

Of the 934 deaths, 752 (80.5%) were affected by at least one delay: 681 deaths (72.9%) by Delay 1, 236 deaths (25.3%) by Delay 2, and 128 deaths (13.7%) by Delay 3. Deaths with no delay accounted for 13.6% (n = 127). The prevalence of Delays 1–3 among maternal deaths in each state and region was estimated. Delay 1 affected all maternal deaths in the Shan (East) State, 87.1% in the Mon State, and 86.5% in the Shan (North) State (Fig. 2). The highest prevalence of Delay 2 was in the Shan (East) State (85.7%), followed by that in the Rakhine State (59.0%) and Yangon Region (41.6%) (Fig. 3). Delay 3 mainly affected maternal deaths in the Kayin State (26.2%), Shan (North) State (25.0%), and Tanintharyi Region (21.9%) (Fig. 4).

Table 1 shows the prevalence of the three delays that were attributed to maternal deaths in Myanmar in 2019 according to the time of maternal death. Of all 934 deaths, 356 (38.1%) occurred during pregnancy, 82 (8.8%) during childbirth, and 496 (53.1%) after childbirth. Of the three delays, Delay 1 was the main delay, comprising 46.0% of maternal deaths. Delay 1 accounted for 52.0% of deaths during the antenatal period, 34.1% of deaths during childbirth, and 43.8% of deaths during the postnatal period. A combination of Delays 1 and 2 was the second most common type of delay (19.9%) in the total deaths; 19.9% of antenatal deaths, 28.0% of deaths during childbirth, and 18.5% of postnatal deaths.

The causes of maternal deaths and specific types of delays are shown in Table 2. In total, eclampsia/pre-eclampsia (PE/E) was the



Fig. 1. The maternal mortality ratio in states and regions of Myanmar in 2019.



Fig. 2. The distribution [n(%)] of Delay 1 in states and regions of Myanmar in 2019.

most common cause of maternal death (21.6%). Postpartum hemorrhage (PPH, 18.2%) and abortion-related complication (13.2%) was the second and third common cause of maternal deaths, respectively. Except for those with unknown causes, most deaths had Delay 1, especially deaths caused by abortion-related complications (95.9%), antepartum hemorrhage (90.5%), and PPH (83.5%). Delay 3 caused the smallest percentage of deaths, but PPH (20.0%), septicemia (20.0%), and PE/E (15.3%) had a higher percentage of Delay 3 among all cases.

To understand the characteristics of maternal deaths and association with types of delay, data of 567 maternal deaths with no missing data or unknown information on delay were analyzed. The age at death of the 567 mothers ranged from 16 to 49 years, and the mean age was 31.0 years. Mothers aged 20 to 39 years accounted for 81.1% (Table 3). Most mothers were married (99.5%), living in rural areas (76.5%), and of Bamar ethnicity (70.7%). Regarding educational level, most mothers had primary school education (43.0%), and were housewives or unemployed (52.6%). Most husbands completed their primary education (43.4%), and 79.0% of the husbands were manual workers. Regarding household income, 54.9% of mothers had \leq 150,000 Myanmar Kyats (MMK) per month, which was approximately 81.0 USD per month (1 USD = 1852.26 MMK, as of June 20, 2022).

Table 2

Causes of maternal death and specific type of delay (N = 934).

Cause of death		Total (N = 934) N (%)	Delay 1 (<i>n</i> = 681) n (%)	Delay 2 (<i>n</i> = 236) n (%)	Delay 3 (<i>n</i> = 128) n (%)	No delay (n = 127) n (%)
Direct cause						
	Abortion-related	123 (13.2)	118 (95.9)	32 (26.0)	4 (3.3)	0 (0.0)
	APH	21 (2.2)	19 (90.5)	10 (47.6)	3 (14.3)	2 (9.5)
	PE/E	202 (21.6)	148 (73.3)	53 (26.2)	31 (15.3)	26 (12.9)
	PPH	170 (18.2)	142 (83.5)	66 (38.8)	34 (20.0)	4 (2.4)
	Septicemia	60 (6.4)	42 (70.0)	17 (28.3)	12 (20.0)	6 (10.0)
	Other	188 (20.1)	123 (18.1)	41 (21.8)	32 (17.0)	40 (21.3)
Indirect cause		163 (17.5)	86 (52.8)	15 (9.2)	12 (7.4)	48 (29.4)
Unknown		7 (0.7)	3 (42.9)	2 (28.6)	0 (0.0)	1 (14.3)

APH, antepartum hemorrhage; PE/E, pre-eclampsia/eclampsia; PPH, postpartum hemorrhage.

Of 934 deaths, 493 deaths had one delay, 225 deaths had two delays, 34 deaths had three delays, 127 deaths had no delays, and delays of 55 deaths were unknown.

Table 3

Socio-demographic characteristics of deceased mothers and delays (N = 567).

		Total $(N = 567)$	Death with Delay 1 $(n = 431)$	Death with Delay 2 $(n = 146)$	Death with Delay 3 $(n = 78)$
Characteristics		N (%)	n (%)	n (%)	n (%)
Age at death (years old)					
	15-19	33 (5.8)	24 (5.6)	10 (6.8)	2 (2.6)
	20-39	460 (81.1)	348 (80.7)	115 (78.8)	64 (82.1)
	40-49	74 (13.1)	59 (13.7)	21 (14.4)	12 (15.4)
Marital status					
	Married	564 (99.5)	428 (99.3)	145 (99.3)	78 (100)
	Others ^a	3 (0.5)	3 (0.7)	1 (0.7)	0 (0.0)
Residence		100 (00 5)	0.0 (00.0)	26 (17.0)	15 (10.0)
	Urban	133 (23.5)	96 (22.3)	26 (17.8)	15 (19.2)
Fabra i altar	Kurai	434 (76.5)	335 (77.7)	120 (82.2)	63 (80.8)
Ethnicity	Damar	401 (70 7)	202 (70.1)	88 (CO 2)	ED (66 7)
	Othors	401 (70.7)	302 (70.1) 120 (20.0)	58 (20.3)	32 (00.7) 36 (22.2)
Education of the mother	others	100 (29.5)	129 (29.9)	38 (39.7)	20 (33.3)
Education of the mother	No education	149 (26 3)	136 (31.6)	46 (31 5)	10 (12.8)
	Primary	244 (43.0)	180 (41.8)	58 (39 7)	38 (48 7)
	Secondary and	174 (30.7)	115 (26.7)	42 (28.8)	30 (38.5)
	higher			(,	(, , , ,
Occupation of the mother	0				
*	Professional/own	52 (9.2)	38 (8.8)	10 (6.8)	9 (11.5)
	business				
	Housewife/	298 (52.6)	231 (53.6)	84 (57.5)	40 (51.3)
	unemployed				
	Manual worker	217 (38.3)	162 (37.6)	52 (35.6)	29 (37.2)
Education of husband					
	No education	125 (22.0)	117 (27.1)	40 (27.4)	11 (14.1)
	Primary	246 (43.4)	187 (43.4)	66 (45.2)	30 (38.5)
	Secondary and	196 (34.6)	127 (29.5)	40 (27.4)	37 (47.4)
	higher				
Occupation of husband					= .
	Professional/own	119 (21.0)	93 (21.6)	27 (18.5)	14 (17.9)
	business	440 (70.0)	220 (70 4)	110 (01 5)	64 (02.1)
Family monthly income (MB/I/)	wanual worker	448 (79.0)	338 (78.4)	119 (81.5)	04 (82.1)
ranny montiny income (MMK)	< 150,000	211 (54.0)	254 (58 0)	00 (61 6)	40 (51 2)
	<u> 150,000 150,000 150,001 </u>	211 (34.9) 256 (45.1)	204 (00.9) 177 (11 1)	56 (28 A)	40 (31.3)
	> 150,001	230 (43.1)	1// (41.1)	30 (30.4)	30 (40.7)

One or more delays were detected for each death.

MMK, Myanmar Kyat.

^a Others include single, divorced, and separated.

^b Others include Kachin, Kayah, Kayin, Chin, Mon, Rakhine, Shan, Paoh, Pa Laung, Wa, Akha, Danu, Inn thar, Lahu, Lisu, Myo, Naga, Ying Nat, Tamel, Nepal, India, Muslim, Chinese, Bengali, and others.1 USD = 1852.26 MMK (as on June 20, 2022).

The obstetrical characteristics showed that 155 mothers (27.3%) were first pregnancy, and 160 mothers (28.2%) had no history of childbirth (Table 4). Of 567 maternal deaths, 49.7% of their pregnancies were unplanned, 26.5% of mothers had no ANC, while 40.7% of mothers received ANC four times or more. Among the 417 mothers who received ANC, 67.9% visited health centers and received ANC mostly by nurses, lady health visitors (LHV), or MW (69.8%). Mothers without underlying medical diseases accounted

for 54.9% of total deaths. It was found that 65.3% of all maternal deaths had avoidable delays.

Delay 1 was the main delay of maternal deaths in this study. Therefore, logistic regression analysis was performed to identify the factors associated with Delay 1. In multiple logistic regression, women whose husbands had primary education (AOR = 0.27; 95% CI 0.10–0.68, P < 0.01) and secondary or higher education (AOR = 0.16; 95% CI 0.06–0.43, P < 0.001) had significantly less

Table 4

Obstetric and gynecological characteristics of deceased mothers and delays (N = 567).

		Total $(N - 567)$	Death with Delay 1 $(n - 431)$	Death with Delay 2 $(n - 146)$	Death with Delay 3 $(n - 78)$
Characteristics		N (%)	n (%)	n (%)	n (%)
History of pregnancy					
	1	155 (27.3)	105 (24.4)	37 (25.3)	28 (35.9)
	2-3	213 (37.6)	156 (36.2)	48 (32.9)	29 (37.2)
	> 4	199 (35.1)	170 (39.4)	61 (41.8)	21 (26.9)
History of childbirth					
	0	160 (28.2)	109 (25.3)	36 (24.7)	25 (32.1)
	1-3	299 (52.7)	232 (53.8)	75 (51.4)	44 (56.4)
	> 4	108 (19.0)	90 (20.9)	35 (24.0)	9 (11.5)
History of abortion/miscarriage					
	No	419 (73.9)	303 (70.3)	109 (74.7)	63 (80.8)
	Yes	148 (26.1)	128 (29.7)	37 (25.3)	15 (19.2)
Planned pregnancy					
	Yes	285 (50.3)	189 (43.9)	75 (51.4)	50 (64.1)
	No	282 (49.7)	242 (56.1)	71 (48.6)	28 (35.9)
Number of ANC visits					
	0	150 (26.5)	144 (33.4)	47 (32.2)	10 (12.8)
	1-3	186 (32.8)	153 (35.5)	63 (43.2)	22 (28.2)
	> 4	231 (40.7)	134 (31.1)	36 (24.7)	46 (59.0)
Place of ANC ^a $(N = 417)$					
	Hospital/clinic	114 (27.3)	52 (18.1)	10 (10.1)	23 (33.8)
	Health center	283 (67.9)	215 (74.9)	82 (82.8)	43 (63.2)
	Others ^b	20 (4.8)	20 (7.0)	7 (7.1)	2 (2.9)
ANC provider ^a $(N = 417)$					
	Doctor/ specialist	119 (28.5)	55 (19.2)	12 (12.1)	23 (33.8)
	Nurses/LHVs/MWs	291 (69.8)	225 (78.4)	85 (85.9)	45 (66.2)
	Others ^c	7 (1.7)	7 (2.4)	2 (2.0)	0 (0.0)
Underlying medical disease					
	No	311 (54.9)	232 (53.8)	83 (56.8)	52 (66.7)
	Yes	128 (22.6)	85 (19.7)	16 (11.0)	9 (11.5)
	Unknown	128 (22.6)	114 (26.5)	47 (32.2)	17 (21.8)
Gestational weeks at maternal death					
	\leq 22 weeks	100 (17.6)	88 (20.4)	21 (14.4)	8 (10.3)
	23-37 weeks	199 (35.1)	199 (35.1)	47 (32.2)	17 (21.8)
	> 38 weeks	268 (47.3)	268 (47.3)	78 (53.4)	53 (67.9)
Avoidable delay					
	Yes	370 (65.3)	311 (72.2)	112 (76.7)	56 (71.8)
	No	55 (9.7)	16 (3.7)	0 (0.0)	1 (1.6)
	Unknown	142 (25.0)	104 (24.1)	34 (23.3)	21 (26.9)

ANC, antenatal care; LHV, lady health visitor; MW, midwife.

^a Mothers after excluding 150 mothers who had no ANC.

^b Home, mobile care, foreign country, and others.

^c Others include auxiliary midwife, community health volunteer, traditional birth attendant, family member, and others.

Delay 1 compared to women whose husband had no education (Table 5). Unplanned pregnancy (AOR = 2.13; 95% CI 1.27–3.57, P < 0.01) was associated with Delay 1 than planned pregnancy. Women whose family monthly income more than 150,001 MMK (AOR = 0.57; 95% CI 0.35–0.93, P < 0.05), who had ANC in one to three visits (AOR = 0.26; 95% CI 0.10–0.70, P < 0.01) and ANC in four visits or more (AOR = 0.09; 95% CI 0.03–0.22, P < 0.001), had significantly less Delay 1.

Discussion

This study showed that the MMR in Myanmar was 106 per 100,000 LB in 2019, and 80.5% of maternal deaths in Myanmar were affected by at least one delay, mostly Delay 1. The prevalence of Delay 1, 2, and 3 varied among the states and regions. The Shan State, for instance, is a mountainous state, consists of many ethnic groups, and the health management is divided into three regions, including North, South and East (Ministry of Health, Myanmar, 2020). Shan (East) had lowest MMR and zero prevalence of Delay 3 comparing to Shan (North) and Shan (South). In contrast, Shan (East) had the highest prevalence of Delay 1 and Delay 2 in the region. The low MMR and zero number of Delay 3 in Shan (East) might be due to good healthcare practices in the region, or due to under-reporting. Further studies should be carried out to

investigate the factors associated with low MMR and no Delay 3 in Shan (East) region.

Factors associated with Delay 1 were the low educational level of the husband, low household income, unplanned pregnancy, and no ANC visits. Mothers who had low household income were more likely to die due to Delay 1. The association between poverty and maternal mortality was reported in many studies (Maine, 2001; Stokoe, 1991; Khan and Pradhan, 2013). Poor income played a role in maternal deaths in many dimensions, including ignorance of health problems and illiteracy of the mothers and families, lack of transportations, and limited access to healthcare services (Hodges, 2001). In addition, husbands also played an important role in making decision to seek healthcare for mothers (Charlet et al., 2017). In our study, the higher the education of the husband, the lower the chance of Delay 1. The result was consistent with a previous studies shown that a husband with no education had strong association with the delay in seeking maternal care (Charlet et al., 2017; Awel et al., 2021). Education and activities to raise awareness on reproductive health, especially safe motherhood and the importance of seeking quality ANC, should be provided to partners of pregnant women.

This study revealed that mothers who had unplanned pregnancies had two times higher Delay 1 than those who had planned pregnancies. Unplanned pregnancies, either untimely or unwanted,

Table 5

Factors associated with Delay 1 among 567 maternal deaths.

Variable		Delay 1		COR (95% CI)	AOR (95% CI)	
		Yes	No n (%)			
		11 (70)	11 (/0)			
Age at death (years old)			o (o= o)			
	15-19	24 (72.7)	9 (27.3)	1 (Reference)	1 (Reference)	
	20-39	348 (75.7)	112 (24.3)	1.17 (0.53–2.58)	0.76 (0.31–1.90)	
	40-49	59 (79.7)	15 (20.3)	1.48 (0.57–3.83)	1.08 (0.37-3.19)	
Residence						
	Urban	96 (72.2)	37 (27.8)	1 (Reference)	1 (Reference)	
	Rural	335 (77.2)	99 (22.8)	1.30 (0.84–2.03)	1.02 (0.58–1.80)	
Ethnicity						
	Bamar	302 (75.3)	99 (24.7)	1 (Reference)	1 (Reference)	
	Others	129 (77.7)	37 (22.3)	1.14 (0.74–1.76)	0.92 (0.53-1.58)	
Education						
	No education	136 (91.3)	13 (8.7)	1 (Reference)	1 (Reference)	
	Primary	180 (73.8)	64 (26.2)	0.27 (0.14-0.51)***	0.63 (0.28-1.41)	
	Secondary and higher	115 (66.1)	59 (33.9)	0.19 (0.10-0.36)***	0.64 (0.27-1.52)	
Occupation	-					
	Professional/own	38 (73.1)	14 (26.9)	1 (Reference)	1 (Reference)	
	business	. ,				
	Housewife/	231 (77.5)	67 (22.5)	1.27 (0.65-2.48)	1.01 (0.43-2.38)	
	unemployed		· · · /			
	Manual worker	162 (74.7)	55 (25.3)	1.09 (0.55-2.15)	0.63 (0.25-1.59)	
Education of husband		()	(/	((
	No education	117 (93.6)	8 (6.4)	1 (Reference)	1 (Reference)	
	Primary	187 (76.0)	59 (24 0)	$0.22 (0.10-0.47)^{***}$	0.27 (0.10-0.68)**	
	Secondary and higher	127 (64.8)	69 (35.2)	0.13 (0.06_0.27)***	0.16 (0.06 - 0.43) ***	
Occupation of husband	secondary and inglici	127 (04.0)	03 (33.2)	0.15 (0.00-0.27)	5.10 (0.00-0.45)	
see putton of husbund	Professional/own	93 (78.2)	26 (21.8)	1 (Reference)	1 (Reference)	
	husiness	55 (10.2)	20 (21.0)	i (neicheiter)	r (nererence)	
	Manual worker	338 (75 4)	110 (246)	0.86 (0.52 1.40)	0.65 (0.22 1.20)	
Family monthly income (MMI/)	wanuar worker	550 (75.4)	110 (24.0)	0.00 (0.33-1.40)	0.03 (0.33-1.23)	
ranny monthy moone (wiwik)	< 150.000	254 (91 7)	57 (10 2)	1 (Poforonco)	1 (Poforence)	
	≥ 150,000 150,001	2J4 (01./)	57 (18.5) 67 (21.2)	1 (RETETETE)	1 (Reference)	
History of programmy	> 130,001	140 (08.8)	07 (31.2)	0.50 (0.34-0.74)	0.37 (0.35-0.93)*	
nistory of pregnancy	1	105 (67 7)	EQ (22.2)	1 (Deferrer)	1 (Deference)	
	1	105 (07.7)	DU (32.3)		1 (Reference)	
	2-3	156 (73.2)	57 (26.8)	1.30 (0.83-2.05)	1.01 (0.35-2.96)	
	> 4	1/0 (85.4)	29 (14.6)	2.79 (1.66-4.69)***	1.50 (0.38-5.85)	
history of childbirth	0	100 (00 1)	F4 (0 + 0)		1 (D (
	U	109 (68.1)	51 (31.9)	1 (Reference)	I (Reference)	
	1-3	232 (77.6)	67 (22.4)	1.62 (1.05–2.49)*	0.78 (0.27-2.24)	
	> 4	90 (83.3)	18 (16.7)	2.34 (1.28-4.29)*	0.43 (0.10–1.87)	
History of abortion/miscarriage						
	No	303 (72.3)	116 (27.7)	1 (Reference)	1 (Reference)	
	Yes	128 (86.5)	20 (13.5)	2.45 (1.46-4.11)***	1.14 (0.57-2.28)	
Planned pregnancy						
	Yes	189 (66.3)	96 (33.7)	1 (Reference)	1 (Reference)	
	No	242 (85.8)	40 (14.2)	3.07 (2.03-4.65)***	2.13 (1.27-3.57)**	
Number of ANC visits						
	0	144 (96.0)	6 (4.0)	1 (Reference)	1 (Reference)	
	1–3	153 (82.3)	33 (17.7)	0.19 (0.08-0.48)***	0.26 (0.10-0.70)**	
	> 4	134 (58.0)	97 (42.0)	0.06 (0.02-0.14)***	0.09 (0.03-0.22)***	
Place of ANC $(N = 417)^{a}$						
	Hospital/clinic	52 (45.6)	62 (54.4)	1 (Reference)	-	
	Health center	215 (76.0)	68 (24.0)	3.77 (2.38-5.96)***	-	
	Others ^b	20 (100.0)	0 (0.0)		-	
ANC provider $(N = 417)^{a}$. ,	. ,			
	Doctors/specialists	55 (46.2)	64 (53.8)	1 (Reference)	-	
	Nurses/LHVs/MWs	225 (77.3)	66 (22.7)	3.97 (2.52-6.24)***	-	
	Othersc	7 (100.0)	0 (0.0)	_	_	
			· · · · · · · /			

COR, crude odds ratio; AOR, adjusted odds ratio; ANC, antenatal care; LHV, Lady health visitor; MW, midwife; MMK, Myanmar Kyat.

^a Mothers after excluding 150 mothers who had no ANC.

^b Others include home, mobile care, foreign country, and others.

^c Others include auxiliary midwife, community health volunteer, traditional birth attendant, family member, and others.*P < 0.05; **P < 0.01; ***P < 0.001.1 USD = 1852.26 MMK (as on June 20, 2022).

have negative consequences for women's health (Institute of Medicine (US) Committee on Unintended Pregnancy, 1995). In this study, 49.7% of deceased mothers had an unplanned pregnancy, and abortion-related complication was the third most common cause of maternal death. In Myanmar, abortion is extremely restricted, and only mothers whose condition meets the indications for abortion to save their lives can have an abortion (Ministry of

Home Affairs, 1861). Myanmar women who have unplanned pregnancies might struggle to visit health facilities for consultations regarding abortions. Therefore, unsafe abortion may be performed without knowledge of its safety and warning signs. The abortion policies need to be reviewed by the MOH, and family planning should be encouraged and strengthened among women who are sexually active.



Fig. 3. The distribution [n(%)] of Delay 2 in states and regions of Myanmar in 2019.

In this study, women who had no ANC visit had significantly more Delay 1. The result was consistent with an interventional study conducted in Uganda and Zambia, which reported that pregnant women who had ANC visits of four times or more could reduce the possibility of Delay 1 up to 23% (Serbanescu et al., 2019). However, among deceased mothers who had ANC in this study, mothers who had ANC with nurses/LHVs/MWs had significantly more Delay 1 than those who had with doctors/specialists (unadjusted OR). Nurses/LHVs/MWs often provide a shorter version of health education compared to ANC provided by doctors. The ability of nurses/LHVs/MWs to identify clinical signs may be limited and lower than that of doctors. In addition, nurses/LHVs/MWs may not have adequate equipment to provide ANC appropriately, especially in rural areas (Magoma et al., 2010; Phommachanh et al., 2019). The quality of ANC should be improved by strengthening the capacity of nurses/LHVs/MWs, and the service package of ANC should be fully understood.

There are some limitations to this study. First, this study had the possibility of underreporting. Although the MDSR Sys-



Fig. 4. The distribution [n(%)] of Delay 3 in states and regions of Myanmar in 2019.

tem organized a nationwide approach, all maternal deaths at refugee/internally displaced person (IDP) camps and some private hospitals might not be reported to the respective township MDSR team. In some hard-to-reach areas, in-time reporting is very difficult because of the shortage of basic health staff. Second, some family members who answered the interview might have subjective or recall bias about the deceased mothers. Finally, this study could not provide information about experiences with maternal deaths, response activities, the current context in clinical sectors, barriers, and constraints by the central, state, regional, and township-level MDSR focal persons, especially from townships with the highest maternal deaths. This is because key informant interviews with the MDSR focal persons could not be conducted in 2019, although the interviews were conducted in the previous years' studies.

In conclusion, the MMR in Myanmar was 106 per 100,000 LB in 2019, 80.5% of maternal deaths had at least one delay, and Delay 1 was the main delay of maternal deaths in Myanmar in 2019. PE/E, PPH, and abortion-related complications were the major causes of

maternal deaths. The husband's low education, low household income, unplanned pregnancy, and no ANC were associated with Delay 1. To reduce maternal deaths caused by Delay 1, educational training for capacity building of healthcare providers who deliver ANC, especially nurses/LHVs/MWs, should be strengthened. Family planning should be promoted to prevent unplanned pregnancies. Education about the danger signs of pregnancy and during childbirth should be provided not only to pregnant women but also to their husbands in communities and at health facilities.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Khine Khine Tun: Conceptualization, Methodology, Formal analysis, Writing – original draft. **Souphalak Inthaphatha:** Conceptualization, Methodology, Formal analysis, Writing – review & editing. **Myint Moh Soe:** Supervision. **Kimihiro Nishino:** Writing – review & editing. **Nobuyuki Hamajima:** Validation, Supervision. **Eiko Yamamoto:** Conceptualization, Validation, Supervision, Writing – review & editing.

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