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Major Determinants of Maternal Near-Miss and Mortality at the Maternity Teaching Hospital, Erbil city, Iraq

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ABSTRACT

Objectives: To find out the major determinants of maternal near-miss (NM)and maternal deaths (MDs) in Erbil city, Iraq, by comparative analysis of maternal NMs and MDs. ***Methods***: We conducted a hospital-based cross-sectional study in the Maternity Teaching Hospital in Erbil city from 1 June to 31 December 2013. All MDs and NMs that occurred in the hospital during the study period were included in the study. Systematic identification of all eligible women was done. This identification included a baseline assessment of the severe pregnancy-related complications using the World Health Organization NM criteria. ***Results:*** Severe preeclampsia and postpartum hemorrhage (PPH) constituted the highest proportions of complications in women with potentially life-threatening conditions (PLTCs) (30.5% and 30.0%, respectively). The highest mortality indexes were those for ruptured uterus (16.7) and severe complications of placenta previa (14.2). Factors that were significantly associated with MD (compared to NM) were hepatic dysfunction (p = 0.046), multiple/unspecified disorders (p = 0.003), arrival as an emergency condition by ambulance (p = 0.015), and history of previous cesarean section (p = 0.013). ***Conclusions:*** Severe preeclampsia and PPH are the main complications that lead to PLTCs. Factors found to be associated with MDs are hepatic dysfunction, multiple/unspecified disorders, arrival as an emergency condition by ambulance, and history of a previous cesarean section.

Maternal death (MD) is the most catastrophic end that could happen to a pregnant woman. It is frequently described as just "the tip of iceberg" and maternal morbidity as the "base".[1–3] Morbidity during pregnancy represents part of a continuum between the extremes of good health and death. Unexpected maternal morbidity that did not result in death but had the potential to do so is classified as a near-miss (NM).[4,5] Potentially life-threatening condition (PLTC) has been used as the initial classification of severity in a continuum of severe morbidity, NM, and death. Organ-based dysfunction is used as a golden standard-set criterion for severe maternal outcome (SMO), including all MDs and maternal near-misses (MNMs).[6–8] The World Health Organization (WHO) working group on maternal morbidity and mortality classifications established a standard definition to describe severe threats to maternal life.[9] This definition is aligned with the International Statistical Classification of Diseases and Related Health Problems (ICD-10).[10] MNM was, therefore, defined as women who nearly died but survived a complication that occurred during pregnancy, delivery, or up to 42 days after the end of her pregnancy.[6,9]

Precise classification of NM morbidity is the first step in analyzing factors that may differentiate survival from death on the continuum from morbidity to mortality.[11] Three different methods have been used to identify MNM cases. These approaches are either a set of clinical criteria defining common diagnostic categories, a set of laboratory based criteria, or a set of management based criteria related to specific interventions representing different levels of an organ(s)/system dysfunction and/or failure.[7,9,12,13]

Although the majority of the deliveries in Iraq occur in public hospitals,[14,15] the Maternal Mortality Ratio (MMR) in Iraq and the Kurdistan region in 2012 was 63 deaths/100 000 live births.[16,17] In depth study of the MNM cases will play a vital role in identifying any deficiencies as well as strengths in the provision of obstetrical services in the

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Kurdistan region and will be useful in correcting and strengthening the obstetrical care, hence further reducing MMR. Additionally, epidemiological data on MNM cases are not available in the Kurdistan region.

The objective of this study, therefore, was to determine the major determinants of MNM and mortality events in Erbil city by comparative analysis.

METHODS

We conducted a hospital-based cross-sectional study at Erbil Maternity Teaching Hospital. Data collection was done between 1 June and 31 December 2013. This hospital is the only public tertiary care hospital with 313 beds in Erbil governorate, in the Kurdistan region of Iraq. Erbil governorate has a population of around 1 613 223.[18] In the previous five years, thousands of displaced Iraqis and Syrian refugees in Erbil increased the population to more than 2 000 000.[19] The hospital provides emergency obstetric and gynecological care 24 hours a day.

All MDs and NMs that occurred in the hospital during the study period were included in the study. A systematic identification of the eligible women for the study was done. This identification included a baseline assessment of the severe pregnancy-related complications using the WHO NM criteria.[20] However, not all WHO criteria were applicable; therefore, a local modification of the criteria was made. For this reason, the severe forms of the five complications of PLTCs used by the WHO (postpartum hemorrhage (PPH), preeclampsia/hemolysis elevated liver enzymes and low platelet count (HELLP), eclampsia, sepsis or systemic infection, and ruptured uterus) were expanded to include cases of the severe forms of complications of abortion, complications of ectopic pregnancies, complications of abruptio placentae, complications of placenta previa, and other complications associated with SMO.

The operational definitions and indicators used at the hospital are those recommended by the WHO.[20] A modified WHO structured questionnaire was filled by direct interview of each woman during her hospital stay. Data on sociodemographic characteristics (including age, education, occupation, and residence), obstetric characteristics, and antenatal care was obtained. The completed questionnaire was double-checked for any missing data. Data not provided by the patient was obtained from their medical record including contributory and associated causes.

The occupation of the women was categorized into three groups: high professionals (medical doctors, dentists, engineers, university teaching staff, lawyers, directors); non-manual skilled or semi-skilled occupations (school teachers, clerks, healthcare workers (excluding doctors, dentists and pharmacists), small business owners); and manual, partly-skilled or unskilled occupations (labor workers, casual workers). Unemployed and retired women were classified according to their previous occupation.[21] Housewives and students were categorized into two separate groups.

Critical intervention describes transfusion of three units of blood products or more, laparotomy (including hysterectomy but excluding cesarean section), and admission to the close observation care unit (COCU) for six hours or more as no intensive care unit (ICU) was available. The term prolonged labor refers to abnormal or difficult childbirth or labor for more than 24 hours. Anemia refers to low hemoglobin level (< 6 g/dL) or clinical signs of severe anemia in women without severe hemorrhage, according to Filippi et al.[22] The mortality index (MI) was calculated by dividing the number of MDs by the number of women with SMO and is expressed as a percentage.[20]

Data were analyzed using IBM SPSS Statistics for Windows, version 20 (IBM Corp., Armonk, N.Y., USA). Chi-squared test of association was used to compare proportions. A p-value ≤ 0.050 was considered statistically significant.

RESULTS

During the seven-month data collection period, 17 353 live births were registered. A total of 180 women with PLTCs were diagnosed, of which 155 women required critical interventions, and 153 developed SMOs ending with 142 MNMs and 11 MDs.

The mean age±standard deviation of women with PLTCs was 29.0±7.0 years (range 15–49 years), 29.0±6.8 years (range 15–49 years) for women with MNMs, and 29.9±9.3 years (range 15–49 years) for MDs (p = 0.881). Mean gravidity was 3.6±2.8 (range 1–16) for MNM and 4.4±3.5 (range 1–11) for MDs (p = 0.780), and parity was 2.9±2.3

Table 1: Sociodemographic and obstetric characteristics of the study population.

Variables	PLTC n (%)	SMO n	MNM n (%)	MD n (%)	*p*-value†
Age, years					
< 20	14 (7.7)	11	9 (6.3)	2 (18.1)	0.082
20–39	156 (86.6)	133	126 (88.7)	7 (63.6)	
≥ 40	10 (5.5)	9	7 (4.9)	2 (18.1)	
Education					
Illiterate	78 (43.3)	69	61 (43.0)	8 (72.7)	0.763
Read and write	40 (22.2)	31	29 (20.4)	2 (18.1)	
Primary school graduate	28 (15.6)	23	22 (15.4)	1 (9.0)	
Intermediate school graduate	13 (7.2)	12	12 (8.4)	0 (0.0)	
Secondary school graduate	10 (5.5)	8	8 (5.6)	0 (0.0)	
Higher education*	11 (6.1)	10	10 (7.0)	0 (0.0)	
Occupation					
High professionals	8 (4.4)	7	7 (4.9)	0 (0.0)	1.000
Non-manual or semi-skilled	7 (3.8)	6	6 (4.2)	0 (0.0)	
Manual partly-skilled or unskilled	14 (7.7)	11	10 (7.0)	1 (9.0)	
Housewife	143 (79.4)	123	113 (79.6)	10 (90.9)	
Student	8 (4.4)	6	6(4.2)	0(0.0)	
Residence**					
Urban	96 (53.3)	84	78 (54.5)	6 (54.5)	1.000
Rural	84 (46.6)	69	64 (45.1)	5 (45.4)	
Gravidity					
1	54 (30.0)	45	43 (30.2)	2 (181)	0.734
2–4	67 (37.2)	57	52 (36.6)	5 (45.4)	
≥ 5	59 (32.7)	51	47 (33.0)	4 (36.3)	
Parity					
0	6 (3.3)	6	5 (3.5)	1 (9.0)	0.351
1–4	134 (74.4)	114	107 (75.3)	7 (63.6)	
≥ 5	40 (22.2)	33	30 (21.1)	3 (27.2)	
Total	**180 (100.0)**	**153**	**142 (100.0)**	**11 (100.0)**	

PLTC: potentially life-threatening condition; SMO: severe maternal outcome; MNM: maternal near-miss; MD: maternal death.
**Diploma, B.Sc., and postgraduate degrees.*
***Categorized according to the availability of municipality services.*
†MNMs and MDs comparison.

(range 0–13) for MNM and 3.6±3.0 (range 0–9) for MDs ($p = 0.570$).

There were no significant variations in the sociodemographic and obstetric characteristics of the two groups [Table 1].

The mean best estimate gestational age in completed weeks (obstetric/neonatal) was 31.5±10.4 weeks (range 6–42 weeks) for MNM cases and 34.6±6.3 weeks (range 22–40 weeks) for cases of MD ($p = 0.999$). A statistically significant difference ($p = 0.004$) was demonstrated between the two categories of dead fetus (stillbirth and early neonatal death). All dead fetuses of MDs were stillbirths while this number was only 36.1% of the MNMs [Table 2].

Severe preeclampsia and PPH constituted the highest proportions of complications in women with PLTCs (30.5% and 30.0%, respectively). The proportions of preeclampsia were 29.5% and 36.3%, while those of severe PPH were 30.9% and 27.2% in MNM and MD cases, respectively. Hypertensive disorder constituted the highest underlying disorder (40.5%) followed by obstetric hemorrhage (34.4%) in women with PLTCs. The proportion of hypertensive disorders were 40.8% and 54.5%, while those of obstetric hemorrhage were 35.2% and 27.2% in MNM and MD cases, respectively. There were no significant differences between the two groups of SMOs in the proportions of severe complications and underlying causes. The highest mortality indexes

Table 2: Obstetric variables and vital status of infants.

Variables	PLTC n = 180	SMO n = 153	MNM n = 142	MD n = 11	*p*-value†
History of antenatal care					
Non-attendance	34 (18.8)	27	23 (16.1)	4 (36.3)	0.132
< 4 visits	75 (41.6)	62	60 (42.2)	2 (18.1)	
≥ 4 visits	71 (39.4)	64	59 (41.5)	5 (45.4)	
Final mode of delivery or abortion*					
Vaginal delivery	61 (33.8)	50	45 (31.6)	5 (45.4)	0.510
Cesarean section	87 (48.3)	76	71 (50.0)	5 (45.4)	
Complete abortion	4 (2.2)	2	2 (1.4)	0 (0.0)	
Curettage/vacuum	9 (5.0)	8	8 (5.6)	0 (0.0)	
Medical methods for uterine evacuation	3 (1.6)	3	2 (1.4)	1 (9.0)	
Laparatomy for ectopic pregnancy	14 (7.7)	12	12 (8.4)	0 (0.0)	
Laparatomy for ruptured uterus	1 (0.5)	1	1 (0.7)	0 (0.0)	
Women discharged still pregnant	1 (0.5)	1	1 (0.7)	0 (0.0)	
Women died still pregnant	0 (0.0)	0	0 (0.0)	0 (0.0)	
Best estimate of gestational age in completed weeks (obstetric/neonatal) for delivery or abortion**	**n = 179**	**n = 152**	**n = 141**	**n = 11**	
< 28	36 (20.1)	31	29 (20.5)	2 (18.1)	
28–36	50 (27.9)	47	44 (31.2)	3 (27.2)	0.649
> 36	93 (51.9)	74	68 (48.2)	6 (54.5)	
Vital status of the infant ≥ 24 weeks	**n = 149**	**n = 127**	**n = 117**	**n = 10**	
Live	92 (61.7)	74	70 (59.8)	4 (40.0)	0.318
Dead	57 (38.2)	53	47 (40.1)	6 (60.0)	
Stillbirth	24 (42.1)	23	17 (36.1)††	6 (100.0)††	0.004
Early neonatal death	33 (57.8)	30	30 (63.8)††	0 (0.0)††	

Data given as n(%).
PLTC: potentially life-threatening condition; SMO: severe maternal outcome; MNM: maternal near-miss; MD: maternal death.
**Three cases delivered in the way to the hospital.*
***One woman with PLTC was discharged while still pregnant and not included in the best estimate of gestational age for delivery or abortion.*
†*MNMs and MDs comparison.*
††*Out of total dead infants.*

(MIs) for specified obstetric causes were those for ruptured uterus (16.7%) and severe complications of placenta previa (14.2%) [Table 3].

Cardiovascular, multiple/unspecified, and coagulation/hemorrhage organ/system dysfunctions constituted the majority of organ dysfunctions developed by women with SMOs (60.7%, 60.1%, and 38.5%, respectively). There were significant differences between cases of MNM and MD in developing hepatic dysfunction (p = 0.046) and multiple/unspecified dysfunctions (p = 0.003) only. The MI was 18.2% for uterine dysfunction/hysterectomy, and 16.1% for hepatic dysfunction. Details of organ dysfunctions are shown in Table 4.

Over half (53.0%) of MNM cases developed on arrival to the hospital, compared with 9.0% of MD cases (p = 0.003). Nearly 55.0% of MDs were referred from other health facilities, compared with 39.4% of MNM cases. All referred MDs were referred from a rural hospital, while this number was only 32.1% of MNMs (p = 0.053). Nearly 55.0% of MDs arrived in emergency condition by ambulance, while only 21.1% of MNM cases arrived by ambulance (p = 0.015). Around 86.0% of women with PLTCs underwent critical interventions. Admission to the COCU was significantly higher (p = 0.020) among MNMs cases (90.0%) than MD cases (60.0%). Previous cesarean was the only contributory/associated cause significantly higher (p = 0.013) among MD cases (54.5%) than MNM cases (19.0%) [Table 5].

DISCUSSION

The need for investment in the field of maternity services could be monitored by assessing the quality

Table 3: Severe complications and underlying causes in the study population.

Severe complications and underlying causes*	PLTC n = 180	SMO n = 153	MNM n = 142	MDs n = 11	*p*-value†	MI (%)
Hypertensive disorders	73 (40.5)	64	58 (40.8)	6 (54.5)	0.528	9.4
Severe preeclampsia	55 (30.5)	46	42 (29.5)	4 (36.3)	0.735	8.7
Eclampsia	18 (10.0)	18	16 (11.2)	2 (18.1)	0.620	11.1
Obstetric hemorrhage**	62 (34.4)	53	50 (35.2)	3 (27.2)	0.749	5.6
Severe postpartum hemorrhage	54 (30.0)	47	44 (30.9)	3 (27.2)	1.000	6.3
Severe complications of abruption	12 (6.6)	12	11 (7.7)	1 (9.0)	1.000	8.3
Severe complications of placenta previa	9 (5.0)	7	6 (4.2)	1 (9.0)	0.413	14.2
Ruptured uterus	6 (3.3)	6	5 (3.5)	1 (9.0)	0.366	16.7
Sepsis or severe systemic infection	14 (7.7)	12	11 (7.7)	1 (9.0)	1.000	8.3
Severe complications of abortion	11 (6.1)	8	8 (5.6)	0 (0.0)	1.000	0.0
Severe complications of ectopic	14 (7.7)	12	12 (8.4)	0 (0.0)	0.603	0.0
Medical/surgical/mental diseases or complications	3 (1.6)	3	3 (2.1)	0 (0.0)	1.000	0.0
Unanticipated complications of management	12 (6.6)	12	10 (7.0)	2 (18.1)	0.208	16.7
Other complications associated with SMO††	4 (2.2)	2	2 (1.4)	0(0.0)	1.000	0.0
Coincidental conditions	2 (1.1)	1	1 (0.7)	0(0.0)	1.000	0.0
Unknown causes	5 (2.7)	5	4 (2.8)	1 (9.0)	0.315	20.0

Data given as n(%).
PLTC: potentially life-threatening condition; SMO: severe maternal outcome; MNM: maternal near-miss; MD: maternal death; IM: mortality index.
**More than one severe complication or underlying cause was detected.*
***Including severe complications of PPH, abruption and placenta previa.*
† MNMs and MDs comparison.
†† Obstetric, medical, and surgical complications other than the above (e.g., diabetes mellitus and pulmonary embolism).

of obstetric care. Because NM cases are likely to have characteristics in common with cases of MD, a thorough investigation of the determinants and factors that result in MNM can provide more information and highlight areas that need better management.[8]

This cross-sectional hospital-based investigation of MNM and mortality was conducted for the first time in the Kurdistan region of Iraq. We used a modified WHO near-miss approach and criteria,[20] adding certain severe complications that fulfill the

Table 4: Organ(s)/system dysfunction and/or failure of women with SMO.

Organ dysfunction*	SMO n = 153	MNM n = 142	MD n = 11	*p*-value†	MI (%)
Cardiovascular dysfunction	93 (60.7)	83 (58.4)	10 (90.9)	0.051	10.7
Respiratory dysfunction	36 (23.5)	31 (21.8)	5 (45.4)	0.131	13.8
Renal dysfunction	42 (27.4)	36 (25.3)	6 (54.5)	0.072	14.3
Coagulation/hemorrhage/system dysfunction	59 (38.5)	52 (36.6)	7 (63.6)	0.107	11.8
Hepatic dysfunction	31 (20.2)	26 (18.3)	5 (45.4)	0.046	16.1
Neurological dysfunction	28 (18.3)	24 (16.9)	4 (36.3)	0.118	14.3
Uterine dysfunction/hysterectomy	11 (7.1)	9 (6.3)	2 (18.1)	0.181	18.2
Multiple/unspecified disorders**	92 (60.1)	81 (57.0)	11 (100.0)	0.003	12.0

Data given as n(%).
SMO: severe maternal outcome; MNM: maternal near-miss; MD: maternal death; IM: mortality index..
**Some women had more than one type of organ dysfunction.*
***Woman with more than one disorder or more than one unspecified disorder.*
† The comparison is between MNMs and MDs.

Table 5: Development of the event, referrals from other facilities, emergency status, critical interventions, contributory, and associated causes of the study population.

Variables	PTLC n = 180	SMO n = 153	MNM n = 142	MD n = 11	*p*-value†
Development of the event					
On arrival	96 (53.3)	84	83 (58.4)	1 (9.0)	0.003
During hospitalization	84 (46.6)	69	59 (41.5)	10 (90.9)	
Referring from another health facility	73 (40.5)	62	56 (39.4)	6 (54.5)	
PHC	14 (19.1)	11	11 (19.6)	0 (0.0)‡	
Rural hospital	26 (35.6)	24	18 (32.1)	6 (100.0)‡	
Private clinic	22 (30.1)	19	19 (33.9)	0 (0.0)‡	0.053
Private hospital	8 (10.9)	5	5 (8.9)	0 (0.00)‡	
Unspecified	3 (4.1)	3	3 (5.3)	0 (0.0)‡	
Emergency status					
Not an emergency	50 (27.7)	36	33 (23.2)	3 (27.2)	
Emergency by ambulance	41 (22.7)	36	30(21.1)	6 (54.5)	0.015
Emergency by private car	89 (49.4)	81	79 (55.6)	2 (18.1)	
Women underwent critical interventions*	155 (86.1)	141	131 (92.2)	10 (90.9)	
Transfusion of blood products	133 (85.8)	121	111 (84.7)	10 (100.0)#	0.357
Laparotomy including hysterectomy and excluding cesarean section	28 (18.0)	26	24 (18.3)	2 (20.0)#	1.000
Admission to COCU	134 (86.4)	124	118 (90.0)	6 (60.0)#	0.020
Contributory/associated causes**					
Anemia	82 (45.5)	68	65 (45.7)	3 (27.3)	0.347
Previous cesarean section	41 (22.7)	33	27 (19.0)	6 (54.5)	0.013
Prolonged/obstructed labor	50 (27.7)	38	34 (23.9)	4 (36.4)	0.467
Other causes or condition	8 (4.4)	8	8 (5.6)	0 (0.0)	1.000

Data given as n(%).
PLTC: potentially life-threatening condition; SMO: severe maternal outcome; MNM: maternal near miss; MD: maternal death; PHC: primary health care; COCU: close observation care unit.
**Some women required more than one critical intervention.*
***Severe cases have more than one contributory cause.*
†MNMs and MDs comparison.
‡Out of those referred from another health facility
#Out of women underwent critical interventions.

clinical, laboratory, and management criteria used to identify a NM. This approach has been used in studies in low-resource setting areas in Malaysia,[23] Indonesia,[24,25] South Africa,[26] Uganda,[27] rural Sudan,[28] Pakistan,[29] Tanzania,[30] and Brazil.[31,32] The adoption of PLTCs in this study as the initial classification in a continuum of maternal severe morbidity has been adopted in other studies in Tanzania,[30] Brazil,[31,32] and Iraq (Baghdad).[33]

We found no significant variations in the sociodemographic and obstetric characteristics of MNM and MD cases, in agreement with studies from Indonesia,[24] rural Sudan,[28] and Tanzania,[30] and the WHO's 2005 global survey on maternal and perinatal health.[34] However, a Turkish study[35] reported a significant difference in the gravidity of both groups. The majority of MNM cases and MDs were in their third and forth decades of life, which reflects the usual age of marriage and reproduction. This finding is in agreement with those reported from Indonesia,[24] Turkey,[35] Brazil,[36] the Netherlands,[37] and Syria.[38] In the WHO's 2005 global survey,[34] NM was significantly associated with higher educational levels. Their finding could be attributed to the tendency of women with higher educational levels to seek early health advice or undergo a cesarean section. In our study, a higher proportion of illiterate women was demonstrated among the MDs group than the MNM cases (non-significant). In agreement with other studies,[24,35–38] most MNMs and MDs were in multiparous or multigravida women. A study in India,[39] reported that primiparas were slightly more in the MNM group.

In this study, we found no significant variations between MNMs and MDs antenatal care, final mode of delivery or abortion, gestational age, and vital

status of the infant. These findings are in agreement with those reported in Tanzania[30] and Turkey.[35] The proportion of non-attendance to antenatal care among the MDs group was twice that of the MNMs group. A study in Nigeria,[40] reported that non-visiting of antenatal care, at least once, was a significant risk factor for MD. Around half of the women with MNMs or MDs delivered by cesarean section, while a study in Baghdad[33] reported this as more than 60%. In Brazil,[31] cesarean section was a significant protective factor for progression to MNMs and MD. Some authors consider cesarean section delivery as a factor that increased the chance of a woman becoming a NM case by five times; however, this association may be influenced by confounding factors.[41] Thus, it is still debatable whether cesarean section is a determinant for NM or is a consequence of this condition.[41,42] The WHO recommends cesarean section rates of 15% and identifies higher rates as both potentially harmful and costly to mothers and health care systems.[43] Cesarean section has been reported to increase maternal morbidity in Latin America.[44]

Most MNMs and MDs cases occurred in the third trimester of gestation. This finding is in agreement with those reported from Indonesia,[24] Pakistan,[29] Tanzania,[30] Turkey,[35] and Syria.[38] In rural Sudan,[28] the gestational age of MNMs was significantly higher than that of MDs. The stillbirth rate in MD cases (100%) was significantly higher than that of MNMs (36%). In the WHO's 2005 global survey,[34] and studies in Brazil[32,44] and Uganda[45] stillbirth was significantly associated with progression of PLTCs to MNMs and MDs.

The main underlying causes and severe complications responsible for NM and MD in our study were severe preeclampsia, severe postpartum hemorrhage, and eclampsia. Other studies revealed similar determinants.[24,28,38,40,46,47] There were no significant variations in the underlying causes and severe complications responsible for MNMs and MDs. This finding indicates that NM review of the disease process can be a useful surrogate of MD analysis.[22,32,40,48] However, in a study from Turkey,[35] significant variations were detected in the proportions of severe complications among the two groups of SMOs. Including the MI for each disease process allows the assessment of the standard of care with respect to common causes of MDs. The highest MI for known severe complications and underlying causes in this study was that of ruptured uterus (16.7%), which constitutes a significant threat to the survival of affected patients and the poorest level of care. Similarly, the level of care provided for pregnancies complicated by severe complications of placenta previa and eclampsia also deserve special attention. These could reflect the lack of adoption of a clear and up-to-date evidence-based protocol for treating these conditions.

In the study from Nigeria,[40] ruptured uterus had the highest MI with significant variations between the two groups of SMOs. Sepsis had the highest MI in studies from rural Sudan,[28] Brazil,[32] Syria,[38] India,[39] and Bolivia.[49]

Hypertensive disorders and obstetric hemorrhage were the most common underlying causes of PLTCs. More than half of MD cases developed hypertensive disorders (with a relatively high MI) similar to that revealed by previous studies.[38,40,46,47,49,50] In South Africa, hypertensive disorders were the commonest direct cause of MDs.[51] In Indonesia,[24] rural Sudan,[28] and Baghdad[33] studies, obstetric hemorrhage constituted the highest cause followed by hypertensive disorders. The highest revealed MI was that for women with unknown causes (20.0%). However, the unknown causes constituted the least frequency (3.3%) of severe complications and underlying causes associated with mortality. These findings could reflect lack of knowledge or incomplete recording and lack of autopsy to evaluate those deaths. In an Indian study in Ahmad Abad,[52] medical disorders had the highest MI.

Cardiovascular dysfunction was the commonest organ/system dysfunction reported in this study for MNMs and MD groups followed by multiple or unspecified disorders. Similar findings were reported in Indonesia[24] and Baghdad.[33] In the mentioned study from Indonesia, the majority (77.3%) of NM cases had one major organ dysfunction, 16.0% had two, 4.6% had three, and 2.0% had four or more. In a study from Baghdad,[33] 212 women with NM were studied; 16 of the MDs had organ dysfunction (one had unspecified organ dysfunction, and nine had multiple organ dysfunctions).

The highest MI was that for uterine dysfunction/hysterectomy (18.2%), although it constituted the least proportion of organ dysfunction in SMOs (7.1%). This high MI is compatible with that of ruptured uterus, which reflects either a delay in diagnosis and care of obstructed labor and previous

scar. Coagulation disorders had the highest MI in the study from Ahmad Abad.[52]

In this study, a significantly higher proportion of MNMs (over 50%) developed on arrival to the hospital, while around 91% of MDs developed during hospitalization. In the study from Uganda,[27] a similar significant association was detected between MD and the timing of complications. In Tanzania,[30] half of women who delivered at home were referred to hospital, and all MDs were identified in-hospital.

The high MDs developed during hospitalization could reflect an error in diagnosis and clinical decision-making or lack of medical supplies and staff proficiency in the management of obstetric emergencies. This is further corroborated by the finding that all referred MDs were referred from rural hospitals. It might also reflect late arrival in critical conditions taking into consideration that more than half of MDs arrived by ambulance in an emergency condition. On the other hand, the high proportion of MNMs on arrival could reflect less of a delay in reaching the hospital or in deciding to seek care. A lack of medical supplies and staff proficiency has been reported in previous studies.[5,38,49] Studies in rural Sudan,[28] Syria,[38] Nigeria,[40] and Uganda[45] reported that most women with PLTCs were referred from other health facilities in critical condition. Similarly, in our study, around two-thirds of women with PLTCs were referred from rural hospital or private clinic in an emergency condition. Most cases of MNMs and MDs arrived in an emergency condition, whether by ambulance or private car, with significant variations between the two groups of SMOs. This finding is similar to that reported in Tanzania.[30] In the Syrian study,[38] most women have arrived in critical condition by private car.

More than 90% of women with SMOs underwent critical intervention(s) with no significant variations between the two SMO groups. However, a significantly higher rate of admission to the COCU was demonstrated among the MNMs group. A similar finding was reported in Uganda.[27] A study from Brazil,[32] found a significant association of MNMs and admission to intensive care for more than two days. Transfusion of blood and blood products was the most common intervention in both groups of SMOs with no significant difference, a finding which was similarly reported in Uganda.[53] In Tanzania,[30] no significant difference in the rate of laparotomy in both groups of SMO was demonstrated, similar to our study. However, in Turkey,[35] a significant difference in the laparotomy rate was demonstrated between the two groups of SMO. A significantly higher proportion of MDs had a previous cesarean section than women with MNM. However, studies in Tanzania[30] and Brazil,[36] revealed no significant variations. In the Nigerian study,[40] no significant variation in the proportion of anemia was detected between the two groups of SMO, which was similarly revealed by this study.

CONCLUSION

Major determinants, including demographic, obstetrics characteristics (antenatal care, final mode of delivery or abortion, gestational age, and vital status of the infant), underlying and associated causes of MNMs and MDs, are similar. Severe preeclampsia and PPH were the main complications leading to PLTCs. Factors found to be associated with MD were hepatic dysfunction, multiple/unspecified disorders, arrival to hospital as an emergency condition by ambulance, and history of previous cesarean section. These findings would guide the hospital administration to issue recommendations that may lead to a decrease in maternal mortalities.

Disclosure

The authors declared no conflicts of interest. No funding was received for this study. The protocol of the study was approved by the Research Ethics Committee of the Kurdistan Board of Medical Specialties. A written informed consent was obtained from each woman (or her guardian) before being enrolled in the study.

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