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ORIGINAL RESEARCH

Severe Hypertensive Disorders of Pregnancy in Eastern Ethiopia: Comparing the Original WHO and Adapted sub-Saharan African Maternal Near-Miss Criteria

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Objectives: To assess life-threatening complications among women admitted with severe hypertensive disorders of pregnancy and compare applicability of World Health Organization (WHO) maternal near-miss (MNM) criteria and the recently adapted sub-Saharan African (SSA) MNM criteria in eastern Ethiopia.

Methods: Of 1,054 women admitted with potentially life-threatening conditions between January 2016 and April 2017, 562 (53.3%) had severe preeclampsia/eclampsia. We applied the definition of MNM according to the WHO MNM criteria and the SSA MNM criteria. Logistic regression was performed to identify factors associated with severe maternal outcomes (MNMs and maternal deaths).

Results: The SSA MNM criteria identified 285 cases of severe maternal outcomes: 271 MNMs and 14 maternal deaths (mortality index 4.9%). The WHO criteria identified 50 cases of severe maternal outcomes: 36 MNMs and 14 maternal deaths (mortality index 28%). The MNM ratio was 36.6 per 1,000 livebirths according to the SSA MNM criteria and 4.9 according to the WHO criteria. More than 80% of women in both groups had MNM events on arrival or within 12 hours after admission. Women without antenatal care, from rural areas, referred from other facilities, and with concomitant hemorrhage more often developed severe maternal outcomes.

Conclusion: Regarding hypertensive disorders of pregnancy, the SSA tool is more inclusive than the WHO tool, while still maintaining a considerably high mortality index indicating severity of included cases. This may enable more robust audits. Strengthening the referral system and improving prevention and management of obstetric hemorrhage in women with hypertensive disorders of pregnancy are required to avert severe maternal outcomes.

Keywords: severe maternal outcomes, hypertensive disorders of pregnancy, maternal near-miss, maternal mortality, sub-Saharan Africa

Introduction

Hypertensive disorders of pregnancy (HDPs) remain one of the leading causes of maternal mortality and severe morbidity.[1–5] According to the World Health Organization (WHO), 14% of global maternal deaths (MDs) in 2014 could be attributed to HDPs.[6] In sub-Saharan Africa (SSA), HDPs are the second-leading cause of MDs and complications.[6,7] In general, the incidence of preeclampsia/eclampsia is higher in Africa than any other region.[8] A recent systematic review in Ethiopia showed a combined prevalence of preeclampsia/eclampsia of 5.5%, with a wide gap

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from 1.2% in a national study to 18.3% in a study conducted in public health institutions in southern Ethiopia.[9] In the 2018 Ethiopian Maternal Death Surveillance and Response System report, 16% of MDs were due to HDPs.[10]

In the maternal health continuum, pregnancy may be uncomplicated or complicated by mild morbidity, potentially life-threatening conditions, life-threatening complications, or death.[11] By applying this continuum to HDPs, preeclampsia may be classified as mild morbidity or severe preeclampsia and eclampsia as severe morbidity or potentially a life-threatening condition, and maternal near-misses (MNMs) from preeclampsia/eclampsia as life-threatening complications preceding MD. Each course can be viewed from this perspective as a progressive chain of events leading to increasingly severe morbidity and ultimately to MD. Understanding the burden at each segment of the continuum and identifying factors affecting the progression from mild morbidity to life-threatening complications (including mortality) is essential for designing appropriate interventions.[12] To facilitate such studies, the WHO proposed MNM criteria, which had been previously found to be less applicable in low-income settings.[13,14] Using a Delphi consensus approach, a panel of experts thus proposed an adaptation of these criteria: the SSA MNM criteria for use in low-income settings.[15]

Factors associated with severe maternal outcomes in HDPs have not been studied in Ethiopia. The objective of this study was to assess the occurrence of MNMs and MDs according to the WHO MNM criteria and its recent adaptation for SSA countries among women admitted with severe preeclampsia and eclampsia in a university and a regional hospital in eastern Ethiopia.

Methods

This study was a sub-analysis of a prospective study conducted on severe maternal morbidity in Hiwot Fana Specialized University Hospital and Jugel Hospital in Harar, eastern Ethiopia.[16] Hiwot Fana is a tertiary-hospital affiliated with the College of Health and Medical Sciences of Haramaya University, where approximately 3,500 births take place annually. Jugel Hospital is a regional public hospital found in the same city, where approximately 2,000 births take place annually. Between January 2016 and April 2017, all cases of potentially life-threatening conditions (severe postpartum hemorrhage, severe preeclampsia, eclampsia, ruptured uterus, sepsis/severe systemic infection, severe complications of abortion) were prospectively identified on a daily basis and followed until discharge.[16] During this period,1,054 women with potentially life-threatening conditions were admitted to both hospitals, of whom 562 were related to HDPs. A total of 7,929 deliveries resulting in 7,404 live births were registered in both hospitals during the same period (Figure 1).

We applied the definition of MNM according to the adapted SSA[15] and WHO MNM criteria[17] to women with severe preeclampsia and eclampsia. For each woman, we retrospectively evaluated the presence of MNM indicators according to the SSA and WHO criteria. SSA MNM criteria were developed for use in low-resource settings, where some of the WHO criteria that focus on organ dysfunction are difficult to apply. SSA MNM criteria include 27 MNM indicators (including 19 from the 25-indicator WHO MNM tool). The most important modification was lowering the threshold for number of units of blood for transfusion in major obstetric hemorrhage from five (in the original WHO MNM criteria) to two units and adding eclampsia, a clinical criterion, to the adapted tool.[15] The comparison of the SSA and WHO MNM criteria with their respective definitions is shown in Table S1.

For all eligible women, data were collected prospectively on sociodemographic characteristics, obstetric conditions and complications, and maternal and perinatal outcomes at discharge. For the current study, we used information related to women having severe preeclampsia and eclampsia only. Case definitions for HDPs were: preeclampsia (new onset of hypertension with proteinuria after 20 weeks of gestation); severe preeclampsia (severe hypertension >160/110 mmHg) plus one of severe headache, blurring of vision, epigastric pain, creatinine >1.1, HELLP (hemolysis, elevated liver enzymes [>2×], low platelet count [<100,000]) syndrome, or pulmonary edema; and preeclampsia with seizure(s) without history of epilepsy, including coma in preeclampsia.[18] Data were collected from medical records after discharge. Trained nurse midwives collected the data under the supervision of the first author (AKT) and other senior researchers from the College of Health and Medical Sciences, Haramaya University.

Data Processing and Analysis

Data were entered using EpiData v3.1 (www.epidata.dk), and SPSS 23 (IBM, Armonk, NY, USA) was used for analysis. Descriptive statistics using frequencies and percentages were used to describe characteristics of participants. Presence of severe maternal outcomes (MNMs and MDs) according to SSA or WHO MNM criteria was the dependent variable. MNM indicators, such as MNM ratio, mortality index, and severe maternal outcome ratio, were

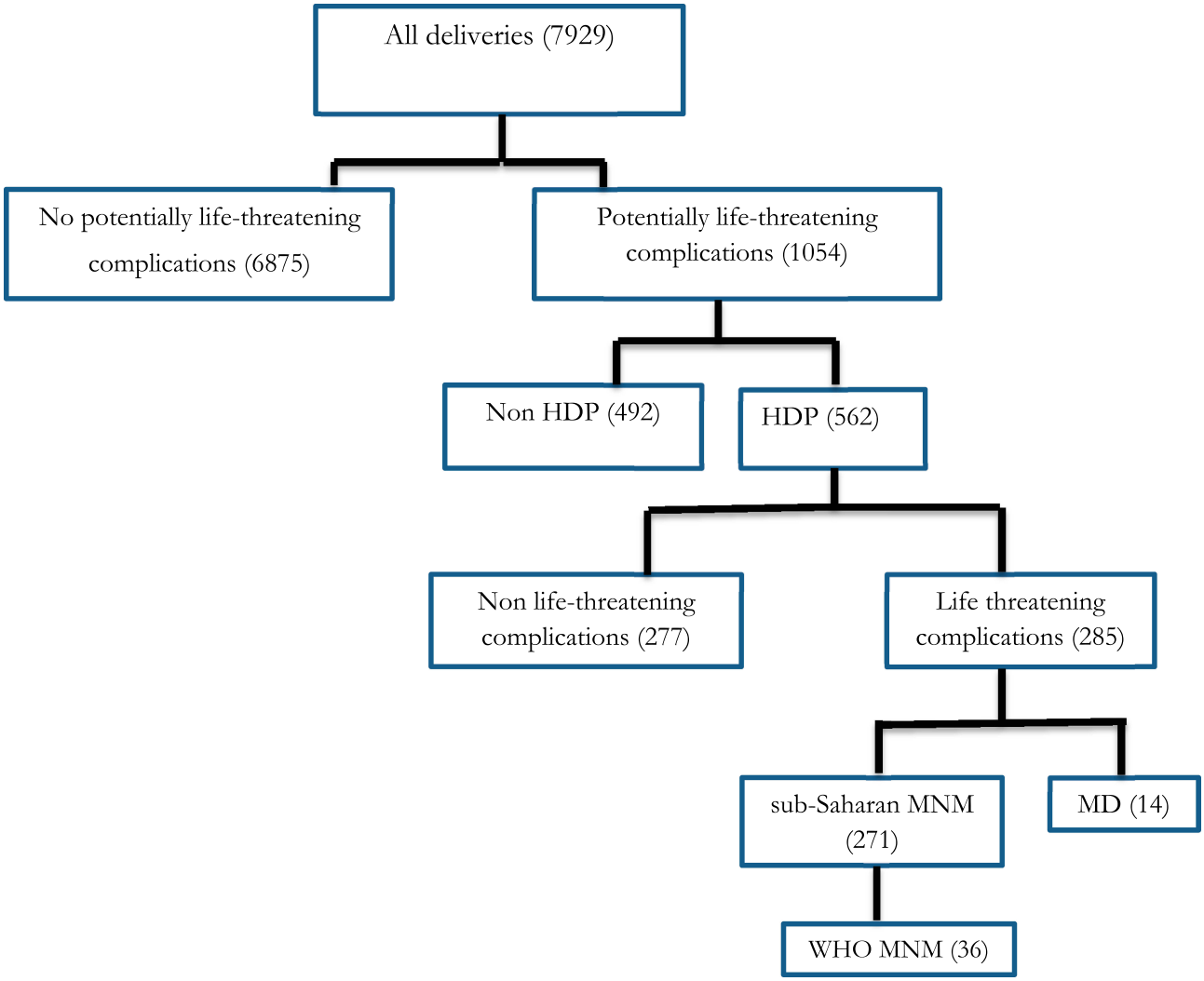

Figure 1 Flowchart of severe HDPs in eastern Ethiopia: comparing the original WHO and adapted sub-Saharan African MNM criteria.
Abbreviations: HDPs, hypertensive disorders of pregnancy; WHO, World Health Organization; MNM, maternal near miss; MDs, maternal death.

calculated and compared between the two classifications. The MNM ratio is the number of MNMs per 1,000 live births. The severe maternal outcome ratio is the of MNM ratio and MDs per 1,000 live births. The mortality index is the proportion of MDs from all women with severe maternal outcomes (MDs/[MNM + MDs]). Possible risk factors for developing severe maternal outcomes were first assessed using binary logistic regression. A multivariate model was then built, retaining variables for logistic regression if $p \leq 0.25$ in the binary model in either the SSA or WHO group. Level of statistical significance for the model was set at $p < 0.05$.

Ethical Considerations

This study was conducted in accordance with the Declaration of Helsinki. The study protocol was reviewed and approved by the Institutional Health Research Ethics Review Committee of the College of Health and Medical Sciences, Haramaya University (C/A/R/D/01/1681/16) in Ethiopia. Data were collected after discharge of the women, and thus did not affect the course or outcome of treatment. Informed consent was not sought, since data were collected from medical records. No identifying information was collected.

Results

Of 562 women with potentially life-threatening conditions related to severe preeclampsia and eclampsia, the WHO MNM criteria identified 50 severe maternal outcomes (8.9%): 36 MNMs and 14 MDs, while SSA MNM criteria identified 285 (50.7%): 271 MNMs and 14 MDs. The mean age of women in the WHO group, SSA group, and MDs were 25.0, 23.8, and 24.4 years, respectively.

No antenatal care, preterm births, and multiparity were commoner among the WHO group and MDs compared to the SSA group. No other significant differences were observed among the three groups (Table 1).

Severe preeclampsia and eclampsia complicated 337 (4.3%) and 225 (2.8%) of all births during the study period (n=7,929). All women with eclampsia and 60with severe preeclampsia (17.8%) fulfilled the SSA MNM criteria, while only 25with eclampsia (11.6%) and 24 with severe preeclampsia (7.1%) fulfilled the WHO MNM criteria.

Table 1 Sociodemographic Characteristics of Study Participants

	SSA, n=285 (%)	WHO, n=50 (%)	MDs, n=14 (%)	*p*-value
Age in years, mean (±SD)	**23.8 (±5.5)**	**25.0 (±5.6)**	**24.4 (±4.8)**	
<20	53 (18.6)	6 (12.0)	2 (14.3)	0.770
20–34	207 (72.6)	38 (76.0)	11 (78.6)	
≥35	25 (8.8)	6 (12.0)	1 (7.1)	
Referred				
Yes	184 (64.8)	35 (70.0)	13 (92.9)	0.081
No	100 (35.2)	15 (30.0)	1 (7.1)	
Booked for ANC				
Yes	94 (33.0)	9 (18.0)	2 (14.3)	0.043
No	191 (67.0)	41 (82.0)	12 (85.7)	
Gestational age (weeks)				
<28	10 (5.5)	2 (5.7)	1 (12.5)	0.049
28–36	103 (56.6)	28 (80.0)	6 (75.0)	
≥37	69 (37.9)	5 (14.3)	1 (12.5)	
Gravida				
1	138 (48.6)	17 (34.0)	6 (42.8)	0.030
2–4	91 (32.0)	13 (26.0)	4 (28.6)	
>4	55 (19.4)	20 (40.0)	4 (28.6)	
Number of children				
0	111 (38.9)	14 (28.0)	3 (21.4)	0.060
1–4	128 (44.9)	20 (40.0)	7 (50.0)	
≥5	46 (16.2)	16 (32.0)	4 (28.6)	
Mode of delivery				
Vaginal	193 (67.7)	33 (70.2)	9 (64.3)	0.903
Cesarean section	92 (32.3)	14 (29.8)	5 (35.7)	
Admission date				
Working day	200 (70.2)	38 (76.0)	9 (64.3)	0.608
Not a working day	85 (29.8)	12 (24.0)	5 (35.7)	

Notes: Bold values: respective Chi Square (X^2) values for the significant ones are as follows: for ANC: X^2 cal =6.2705; Gestational age: X^2 cal=9.5597; Gravida: X^2 cal=10.7168.
Abbreviations: ANC, antenatal care; SSA, sub-Saharan Africa; WHO, World Health Organization, MDs, maternal deaths.

The severe preeclampsia/eclampsia–related MNM ratio was 4.9 per 1,000 live births according to WHO MNM criteria and 36.6 according to SSA criteria. Details of severe preeclampsia/eclampsia–related complications and MNM indicators stratified by WHO or SSA MNM criteria are summarized in Table 2. Hemorrhage was diagnosed in eleven (22%) women in the WHO group and 27 (9.5%) in the SSA group. Blood products were administered to 38 (13.3%) women, of whom only eleven (3.9%) received five or more units (Table 3).

Concerning the distribution of MNM events in the two groups, respiratory dysfunction (n=23) followed by coagulation dysfunction (n=16) were commonest in the WHO group. In the SSA group, eclampsia (n=225) followed by coagulation dysfunction (n=34) were the most prevalent. Of 225 women with eclampsia, only 26 (11.6%) fulfilled the WHO MNM criteria. The remaining (n=199; 88.4%) did not fulfill WHO MNM criteria, because organ dysfunction was not mentioned in their files. The mortality index was 28% for the WHO group and 4.9% in the SSA group. For all MNM events, unsurprisingly mortality indices were equal or higher in the WHO group compared to the SSA group (Table 4).

More than 80% of women in both groups had MNMs already on arrival or within 12 hours after admission. A majority of those with MNMs on arrival were referred from other facilities: 28 (68.3%) in the WHO group and 163 (64.9%) in SSA group. The mortality index was higher among women presenting to hospitals with MNMs compared to MNMs occurring in hospital after admission (Table 5). In women fulfilling SSA MNM criteria, severe maternal outcomes were higher in those who were referred (adjusted OR 1.97, 95% CI 1.13–3.41), had not received antenatal care (adjusted OR 3.13, 95% CI 1.77–-5.54), and rural residents (adjusted OR 2.32, 95% CI 1.11–-4.87). In the WHO group, women with concomitant obstetric hemorrhage (adjusted OR 3.75, 95% CI 1.10–12.76), who were referred (adjusted OR 3.34, 95% CI 1.20–9.31), and with no antenatal care (adjusted OR 3.17, 95% CI 1.03–9.76) were at increased risk of developing severe maternal outcomes. No statistically significant association was observed between severe maternal outcomes and age, gestational age, number of pregnancies, or mode of delivery in either group (Table 6).

Discussion

The MNM ratio among women with severe HDPs in eastern Ethiopia was 4.9 per 1,000 live births according to WHO MNM criteria and 36.6 according to the adapted

Table 2 Distribution of HDP-related Complications and MNM Indicators in Eastern Ethiopia

	All HDPs, n (%)	All SMOs		MNMs		MNM Ratio		MMR	SMO Ratio		MNM:MDs		MI		CFR
		SSA	WHO	SSA	WHO	SSA	WHO		SSA	WHO	SSA	WHO	SSA	WHO	
SPE	337(60)	60	24	55	19	7.4	2.6	67.5	8.1	3.2	11	3.8	8.3	20.8	1.5
Eclampsia	225(40)	225	26	216	17	29.2	2.3	121.6	30.4	3.5	24	1.9	4.0	34.6	4.0
Total	562(100)	285	50	271	36	36.6	4.9	189.1	38.5	6.8	19.4	3.6	4.9	28.0	2.5

Abbreviations: S-PE, severe preeclampsia; SSA, sub-Saharan Africa; WHO, World Health Organization; HDPs, hypertensive disorders of pregnancy; MNMs, maternal near-misses; MMR, maternal mortality ratio; SMOs, severe maternal outcomes (MNMs + MDs); MDs, maternal deaths; MI, mortality index (MDs/SMOs × 100); CFR, casefatality rate.

Table 3 Distribution of Underlying and Contributing Factors of Severe Maternal Outcomes Among Women with HDPs in Eastern Ethiopia

	SSA Tool, n (%)	WHO Tool, n (%)
Underlying complications		
Total	**285**	**50**
Severe preeclampsia	60 (21.1)	24 (48.0)
Eclampsia	225 (78.9)	26 (52.0)
Obstetric hemorrhage*	27 (9.5)	11 (22.0)
Abortion-related[a]	2 (0.7)	0
Abruptio placenta	5 (1.8)	2 (4.0)
Placenta previa	2 (0.7)	0
Uterine rupture	3 (1.1)	2 (4.0)
Postpartum hemorrhage	10 (3.5)	6 (12.0)
Other	5 (1.8)	1 (2.0)
Sepsis or severe systemic infection*	19 (6.7)	8 (16.0)
Contributing factors		
Anemia (<7g/dl)	31 (10.9)	8 (16.0)
Previous cesarean section	9 (3.2)	2 (4.0)
Critical interventions or ICU admission	141 (49.5)	37 (74)
Use of blood products	38 (13.3)	11 (22.0)
Admission to ICU	40 (14.0)	23 (46.0)
Cesarean section	87 (30.5)	13 (26.0)
Laparotomy	4 (1.4)	4 (8.0)

Notes: *In women with HDPs; [a]definition of abortion in Ethiopia (<28 weeks).
Abbreviation: ICU, intensive care unit.

SSA MNM criteria. Using the adapted SSA MNM criteria, we were able to identify robustly that severe maternal outcomes were higher among women who did not have any antenatal care, were referred from other facilities, and were rural residents. Increased risk of severe maternal outcomes among women with concomitant obstetric hemorrhage were observed among cases fulfilling WHO MNM criteria only, indicating the severity of these cases.

The contribution of severe HDPs among women with potentially life-threatening conditions (53.3%) was comparable with other studies in Ethiopia[19,20] and Nigeria.[21] Severe maternal outcomes related to severe preeclampsia/eclampsia according to WHO criteria (6.8 per 1,000 live births) was lower than a finding from Uganda (8.6) and much lower than that of Nigeria (24.0).[5,22] It was higher, however, than in a study from Brazil (4.2).[23] This may be related to differences in study setting and health-care systems. Our study was institution-based in a low institutional delivery (26%) setting where most women with minor complications may not come to the hospital, where mainly high-risk women come.[24]

The risk of maternal mortality is higher among women with organ dysfunction (fulfilling the WHO MNM criteria) and highest among those with uterine dysfunction (60%), followed by cardiovascular (50%) and coagulation dysfunction (50%). Although low in absolute number (n=4), mortality was highest (75%) among women who underwent laparotomy in the SSA group. Overall, the mortality index was 4.9% and 28% among cases in the SSA and WHO groups, respectively. The mortality index for WHO MNMs wass lower than in the study from Nigeria (49.2%),[23] but higher than in the study from Uganda (8.3).[5]

Many women with severe maternal outcomes already have organ dysfunction on arrival, which makes treatment in hospitals too late to save the life of the woman or prevent organ failure. This advanced stage of illness on admission may be attributed to the low institutional delivery rate and a poorly functioning referral system.[24,25] Community-level interventions are required for meaningful reductions in maternal mortality due to HDPs.[25,26] Health workers in the community and lower district hospitals — who were capable of identifying and initiating treatment, but lack refresher training — should be refreshed on signs and symptoms, timely referral, and prophylactic use of magnesium sulfate.[27–29] They should also be vigilant about the risk of obstetric hemorrhage, since this

Table 4 Distribution of MNM Events in Women with HDPs in Eastern Ethiopia

	Sub-Saharan Africa			World Health Organization		
	MNMs, n (%)	MDs, n (%)	MI (%)	MNMs, n (%)	MDs n (%)	MI (%)
Cardiovascular dysfunction	7 (2.6)	7 (50.0)	50.0	7 (19.4)	7 (50.0)	50.0
Respiratory dysfunction	15 (5.5)	8 (57.1)	34.8	15 (41.7)	8 (57.1)	34.8
Uterine dysfunction	2 (0.7)	3 (21.4)	60.0	2 (5.6)	3 (21.4)	60.0
Coagulation dysfunction	26 (9.6)	8 (57.1)	23.5	8 (22.2)	8 (57.1)	50.0
Renal dysfunction	1 (0.4)	1 (7.1)	50.0	1 (2.8)	1 (7.1)	50.0
Hepatic dysfunction	5 (1.8)	1 (7.1)	16.7	5 (13.9)	1 (7.1)	16.7
Neurologic dysfunction	7 (2.6)	6 (42.9)	46.2	7 (19.4)	6 (42.9)	46.2
Eclampsia	216 (79.4)	9 (64.3)	4.0	17 (47.2)	9 (64.3)	34.6
Severe preeclampsia with ICU admission	14 (5.2)	4 (28.6)	22.2	5 (13.9)	4 (28.6)	44.4
Sepsis or severe systemic infections	16 (5.9)	3 (21.4)	15.8	5 (13.9)	3 (21.4)	37.5
Pulmonary edema	6 (2.2)	2 (14.3)	25.0	4 (11.1)	2 (14.3)	33.3
Total	271 (100)	14 (100)	4.9	36 (100)	14 (100)	28.0

Abbreviations: ICU, intensive care unit; MNMs, maternal near-misses; MDs, maternal deaths; MI, mortality index (MDs/MNM + MDs).

Table 5 SMOs and MNM Indicators Among Women with HDPs in Eastern Ethiopia

	MNM Indicators	
	SSA	WHO
1. All live births in the population under surveillance	7404	7404
2. SMOs (n)	285	50
MDs (n)	14	14
MNMs (n)	271	36
3. Overall near-miss indicators		
SMO ratio (per 1,000 live births)	38.5	6.8
MNM ratio (per 1,000 live births)	36.6	4.9
MNM-mortality ratio (MNMs:MDs)	19.4	2.6
Mortality index (%)	4.9	28
4. Hospital-access indicators		
SMO cases presenting the organ dysfunction or maternal death within 12 hours of hospital stay (SMO_{12}; n)	251	41
Proportion of SMO_{12} cases among all SMO cases	88.1	82.0
Proportion of SMO_{12} cases coming from other health facilities	64.9	68.3
SMO_{12} rate (per 1,000 live births)	33.9	5.5
SMO_{12} mortality index (%)	4.8	29.3
5. Intrahospital care		
Intrahospital SMOs (n)	34	9
Intrahospital SMO rate (per 1,000 live births)	4.6	1.2
Intrahospital mortality index (%)	5.9	22.2

Abbreviations: SMO, severe maternal outcome; SSA, sub-Saharan Africa; WHO, World Health Organization; MNM, maternal near-miss; MDs, maternal deaths.

appears to be a predilecting factor for severe maternal outcome among women with HDPs.[30]

Despite the reported high use of magnesium sulfate for prophylaxis (95.8%) or treatment (96.4%), lack of adequate intensive care units and late arrival of women results in a high mortality index. This highlights the need to assess quality of care or timeliness of prophylaxis or treatment. Further audits of appropriateness of management and opportunities for improvement (including prereferral management) are required to improve quality of obstetric care and avert preventable maternal mortality.[31,32]

Strengths of this study were the use of a prospective design in case selection and use of diagnosis made by the treating clinician. This study also had some limitations. First, although treatment with magnesium sulfate was assessed, data on its timing were not collected, and we are unable to comment about any delays. Second, we feel that incompleteness of medical records may affect our understanding about timing of prophylactic use of magnesium sulfate among women with eclampsia. We also feel that the existing low institutional delivery rate (26%) may result in underestimation of the denominator (live births),[24] since the majority of hospital births are among high-risk referred cases.[33] Therefore, findings from this study may not reflect a population-based estimate of the condition.

In this low-resource setting, we feel that for audit purposes, the adapted SSA MNM tool should be used instead of the strict WHO tool, as the mortality index is still 4.9%, indicating the severity of cases.[15,34,35] Many lessons to be learned will be missed by lookingonly at the cases identified by the WHO MNM tool. One of the major aims of treatment is to prevent organ dysfunction in women with complications and thus focus on organ dysfunction, as identification criteria will not address this major task. Improvement of case detection in the

Table 6 Factors Associated with Severe Maternal Outcomes Among Women with HDPs in Eastern Ethiopia

		SSA MNM Tool		WHO MNM Tool	
		cOR	aOR	cOR	aOR
Age (years)	<20 20–34 ≥35	1.0 0.67 (0.42–1.06) 0.57 (0.29–1.12)	1.0 1.70 (0.76–3.78) 1.89 (0.51–7.0)	1.0 1.38 (0.57–3.38) 1.69 (0.52–5.54)	1.0 3.55 (0.57–22.29) 1.75 (0.15–20.36)
Gravidity	1 2–4 ≥5	1.0 0.67 (0.45–0.98) 0.50 (0.32–0.77)	1.0 1.05 (0.48–2.27) 0.77 (0.37–1.62)	1.0 0.96 (0.45–2.02) 2.27 (1.14–4.50)	1.0 0.74 (0.20–2.70) 1.65 (0.47–5.78)
Referred	No Yes	1.0 1.95 (1.39–2.74)	1.0 1.97 (1.13–3.41)	1.0 1.87 (1.0–3.51)	1.0 3.34 (1.20–9.31)
Received ANC	Yes No	1.0 3.43 (2.43–4.86)	1.0 3.13 (1.77–5.54)	1.0 4.70 (2.22–9.79)	1.0 3.17 (1.03–9.76)
Mode of delivery[a]	Vaginal CS	1.0 0.71 (0.49–1.01)	1.0 1.31 (0.75–2.28)	1.0 0.68 (0.35–1.33)	1.0 0.89 (0.31–2.53)
Gestational age (weeks)	20–31 32–36 ≥37	1.0 1.15 (0.68–1.94) 1.00 (0.59–1.69)	1.0 1.05 (0.48–2.27) 0.77 (0.37–1.62)	1.0 1.26 (0.55–2.89) 0.28 (0.09–0.85)	1.0 2.02 (0.57–7.16) 0.31 (0.07–1.40)
Hemorrhage	No Yes	1.0 1.05 (0.60–1.87)	1.0 2.37 (0.98–5.76)	1.0 3.24 (1.54–6.80)	1.0 3.76 (1.10–12.76)
Address	Urban Rural	1.0 3.76 (2.13–6.63)	1.0 2.32 (1.11–4.87)	1.0 2.68 (0.80–9.04)	1.0 0.94 (0.22–4.10)

Note: [a]"No delivery" and abortions excluded.
Abbreviations: SSA, sub-Saharan Africa; MNM, maternal near-miss; cOR, crude OR; aOR, adjusted OR; WHO, World Health Organization.

SSA tool was achieved by two notable changes: lowering the threshold of blood transfusion to at least two units and including eclampsia in MNM criteria.[15] Lack of adequate blood for transfusion and limited resources for investigation could be the major reasons for (inevitable) underreporting of MNMs using the WHO criteria. In addition, in most hospitals in low-income settings, it is unlikely for a woman to receive five or more units of blood, due to restricted availability.[36] Limited infrastructure for diagnosis or management and lack of specialists in intensive care make the use of the WHO criteria impractical in many low-resource settings.

In conclusion, the adapted SSA MNM tool identifies a larger number of cases amenable to audit than the WHO MNM tool, which may help in preventing organ dysfunction. The SSA MNM tool should be used for averting severe maternal outcomes related to HDPs, as reverting cases fulfilling the WHO MNM criteria is difficult because of organ dysfunction or failure.[15,17] The majority of women with severe maternal outcomes reached hospitals in a critical condition, and thus an important key to improve outcomes of HDPs seems to be at lower-level facilities and in strengthening the referral system. Quality of care for women with severe HDPs should be audited to identify areas of improvement and prevent organ dysfunction and MDs.

Disclosure

The authors report no conflicts of interest in this work.

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