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Maternal near miss in low-resource areas

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Abstract

Objective: To describe the Global Network Near-Miss Maternal Mortality System and its application in seven sites.

Methods: In a population-based study, pregnant women eligible for enrollment in the Maternal and Newborn Health Registry at seven sites (Democratic Republic of the Congo; Guatemala; Belagavi and Nagpur, India; Kenya; Pakistan; and Zambia) between January 2014 and April 2016 were screened to identify those likely to have a near-miss event. The WHO maternal near-miss criteria were modified for low-resource settings. The ratio of near-miss events to maternal deaths was calculated.

Results: Among 122 707 women screened, 18 307 (15.0%) had a potential near-miss event, of whom 4866 (26.6%; 4.0% of all women) had a near-miss maternal event. The overall maternal mortality ratio was 155 per 100 000 live births. The ratio of near-miss events to maternal deaths was 26 to 1. The most common factors involved in near-miss cases were the hematologic/coagulation system, infection, and cardiovascular system.

Conclusion: By using the Global Network Near-Miss Maternal Mortality System, large numbers of women were screened for near-miss events, including those delivering at home or a low-level maternity clinic. The 4.0% incidence of near-miss maternal mortality is similar to previously reported data. The ratio of 26 near-miss cases to 1 maternal death suggests that near miss might evaluate the impact of interventions more efficiently than maternal mortality.

KEYWORDS

Low- and middle-income countries; Maternal mortality; Maternal near miss

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1 | INTRODUCTION

Maternal mortality and severe maternal morbidity are increasingly recognized as indicators of the quality of obstetric care in both health systems and individual facilities.[1,2] On the one hand, because maternal deaths are rare even in settings with relatively high maternal mortality, the number of deaths is often inadequate to evaluate interventions aiming to improve maternal outcomes. On the other hand, measures of maternal morbidity can be vague, with varying definitions and inconsistent reporting across settings or over time.[2]

To augment maternal mortality data, WHO developed the concept of "maternal near miss" as the near death of a woman from a complication during pregnancy or childbirth, or within 42 days of termination of pregnancy.[3] WHO also developed a tool to classify near miss.[3,4] Subsequently, numerous studies have used these criteria to define near miss worldwide.[5–23]

The WHO near-miss criteria were primarily designed for hospital settings under the assumption that these conditions usually result in maternal death when they occur outside the health facility.[4] However, numerous adaptations have been used across studies and in different settings. Depending on the geographic location, population, and specific details of the classification, studies of maternal near miss in low- and middle-income countries (LMICs) report frequencies ranging from less than 1% to more than 15%[5–21] (Table 1). Almost all studies have been conducted in health facilities, ranging from tertiary referral hospitals to maternity care centers. The wide range of near-miss incidence illustrates the impact of definitions, locations, and populations on the outcome, and also points to the need for a universal system to define maternal near-miss mortality in LMIC settings to facilitate comparisons using similar criteria across settings and over time.

One of the challenges to the widespread use of existing near-miss data tools in LMIC settings has been the reliance on data generally gathered in advanced hospital settings.[1] Because of the wide range in healthcare systems, a tool that is generalizable to various settings and that can be used on a population rather than a facility basis would be more appropriate.

To address these gaps, a near-miss classification approach—the Global Network Near-Miss Maternal Mortality System—has been developed. This system is based on the WHO near-miss tool,[7] but has been designed specifically for low-resource settings where many deliveries occur in the home or in facilities with limited laboratory testing or interventions such as blood transfusion. The aim of the present study was to implement this system to capture near-miss events, and to determine the rate of these events in sites of the Global Network.

2 | MATERIALS AND METHODS

The present prospective, population-based, observational study was performed between January 1, 2014, and April 30, 2016, at seven Global Network sites in the Democratic Republic of the Congo (DRC), Guatemala, India, Kenya, Pakistan, and Zambia as part of the Global Network Maternal and Newborn Health (MNH) Registry. The institutional review boards and ethics committees at the participating study sites (Aga Khan University, Karachi, Pakistan; Kinshasa School of Public Health, Kinshasa, DRC; Moi University, Eldoret, Kenya; University of Zambia, Lusaka, Zambia; INCAP, Guatemala City, Guatemala; Lata Medical Research Foundation, Nagpur, India; and KLE University's JN Medical College, Belagavi, India), their affiliated US partner institutions (University of Alabama at Birmingham, University of North Carolina at Chapel Hill, Columbia University, University of Indiana, Thomas Jefferson University, and Massachusetts General Hospital), and the data coordinating center (RTI International) approved the study. Every woman enrolled in the MNH Registry provided informed consent regarding the use of data related to her pregnancy.

TABLE 1 Rates of maternal near miss in low- and middle-income countries, by country and study.

Country	Setting	Year	No. of live births	No. of near-miss events[a]	Maternal mortality per 100 000	Ratio of near miss to maternal mortality[b]	Study
Africa							
Ethiopia	Hospital	2011–2012	35 047	2568 (7.3)	728	12:1	Gebrehiwot and Tewolde[5]
Mozambique	Hospital	2008	27 916	564 (2.0)	254	8:1	David et al.[6]
Nigeria	Hospital	2012–2013	91 724	1451 (1.6)	1088	2:1	Oladapado et al.[7]
South Africa	Hospital	2013–2014	26 614	1256 (4.5)	71	59:1	Soma-Pillay et al.[8]
Tanzania	Hospital	2009–2011	9471	216 (2.4)	350	7:1	Nelissen et al.[9]
Uganda	Hospital	2013–2014	25 840	695 (2.7)	503	5:1	Nakimuli et al.[10]
Asia							
India	Hospital	2011–2012	27 958	112 (0.4)	202	2:1	Kalra and Kachhwaha[11]
India	Hospital	2011–2012	5273	633 (9.9)	4684	3:1	Pandey et al.[12]
Indonesia	Hospital	2003–2004	5669	763 (13.4)	NA	NA	Adisasmita et al.[13]
Laos	Population	2011	1215	11 (0.9)	178	5:1	Luexay et al.[14]
Malaysia	Hospital	2014	21 579	47 (0.2)	9	23:1	Norhayati et al.[15]
Nepal	Hospitals	2012	41 859	157 (0.4)	62	6:1	Rana et al.[16]
Pakistan	Hospital	2006	868	91 (10.5)	691	15:1	Mustafa and Hashmi[17]
Latin America							
Brazil	Hospital	2012–2013	5841	56 (1.0)	171	6:1	Madeiro et al.[18]
Brazil	Hospital	2005	4491	95 (2.1)	89	24:1	Amaral et al.[19]
Other							
Egypt, Palestine, Lebanon, Syria	Hospital	2011	9063	77 (0.8)	66.2	12:1	Bashour et al.[20]
Syria	Hospital	2006–2007	28 025	901 (3.3)	54.8	60:1	Almerie et al.[21]

Abbreviation: NA, not available.
[a]Values in parentheses are percentage of live births.
[b]Rounded to number of cases.

The seven Global Network sites included in the present study have been described in detail previously.[24] All pregnant women living in the defined geographic areas are enrolled in the MNH Registry by trained staff during pregnancy and followed up from consent until 6 weeks after delivery. Pertinent data related to the pregnancy and its outcomes are collected prospectively by maternal, family, and provider interview, and by chart review including specific data related to maternal mortality and near-miss events.

For the Global Network Near-Miss Maternal Mortality System, the definition of a near-miss event was based on the original WHO criteria. However, because many of the WHO criteria assume hospital admission, the Global Network Near-Miss Maternal Mortality System criteria were limited to those that can be generally obtained irrespective of the tests and procedures available to the population to develop a system applicable to low-resource settings. The specific criteria were selected after extensive discussion with investigators representing each site. Owing to the increasing rates of facility utilization, several WHO management criteria were retained, although these data were often unavailable for the present study population.

Table 2 summarizes the criteria in both the Global Network and the WHO near-miss systems. Consistent with the WHO system, the Global Network definition categorizes the near-miss criteria by organ system dysfunction (i.e. cardiovascular, respiratory, renal, hematologic/coagulation, hepatic, and neurologic) and/or infection. Near-miss data are collected after delivery and 42 days later by a trained registry administrator through interviews of patients, family, and providers, and review of medical records when available. Maternal deaths during pregnancy up until 42 days after delivery are documented.

Because the Global Network MNH Registry enrolls approximately 70 000 pregnant women annually, it was deemed impractical to review each woman's records to determine cases of near miss. Therefore, screening criteria were developed to determine which pregnancies should be further evaluated for maternal near miss (Box 1). These criteria included specific types of maternal and perinatal signs, symptoms, and outcomes associated with near-miss cases, in addition to broad criteria defined as any other symptoms or signs of life-threatening illness at any time during the pregnancy or in the postpartum period.

TABLE 2 Global Network and WHO near-miss criteria.

	Global Network System		WHO System		
Organ system	Clinical criteria	Management criteria	Clinical criteria	Management-based proxies	Lab markers[a]
Cardiovascular	Shock; Cardiac arrest	Cardio-pulmonary resuscitation	Shock; Cardiac arrest	Use of continuous vasoactive drugs;[a] Cardio-pulmonary resuscitation	pH <7.1; Lactate >5 mmol/L
Respiratory	Acute cyanosis; Gasping; RR >40 or <6	Intubation and ventilation not related to anesthesia	Acute cyanosis; Gasping; RR >40 or <6	Intubation and ventilation not related to anesthesia	Oxygen saturation <90%; PaO_2/FiO_2 <200 mm Hg
Renal	Non-responsive to fluids	Dialyses for acute renal failure	Non-responsive to fluids	Dialyses for acute renal failure	Creatinine >300 μmol/L or >3.5 mg/dL
Hematologic/ coagulation	Failure to form clots	Transfusion (any volume)[b] Surgical procedure to stop bleeding[b]	Failure to form clots	Transfusion of >5 units of blood/red cells	Acute severe thrombocytopaenia
Hepatic	Jaundice with pre-eclampsia/ eclampsia	–	Jaundice with pre-eclampsia/ eclampsia	–	Bilirubin >100 μmol/L or >6.0 mg/dL
Neurologic	Loss of consciousness; Stroke;Fits;Paralyses	–	Loss of consciousness; Stroke;Fits;Paralyses	–	–

Abbreviations: RR, respiratory rate; PaO_2, partial pressure of arterial oxygen; FiO_2, fraction of inspired oxygen.
[a]Excluded from Global Network system.
[b]Added to Global Network system.

For the present analysis, all pregnant women eligible for enrollment in the MNH Registry during the study period were screened. Women who had a spontaneous abortion or other pregnancy loss at less than 20 weeks were excluded. Pregnancy outcomes were partitioned into one of three categories: maternal death, near-miss event, or alive at postpartum day 42 without a near-miss event. Cases of maternal death were not classified as near miss. It was possible for a participant to have one near-miss event identified at delivery and another at the 42-day visit.

All data were entered into a customized Microsoft Access 2010 database (Microsoft Corporation, Redmond, WA, USA) on local computers and reviewed at the study site before transmission via an encrypted secure system to the data coordinating center. Additional edits were conducted centrally and resolved at each site. Descriptive statistics were used to assess the frequency of near-miss events by study site. All data were analyzed using SAS version 9.4 (SAS Institute, Cary, NC, USA).

Box 1 Global Network screening criteria for near-miss events.

- Obstructed labor, prolonged labor, failure to progress.
- Severe prepartum, intrapartum, or postpartum hemorrhage.
- Evidence of hypertensive disease, severe pre-eclampsia, eclampsia, or seizures.
- Breech, transverse or oblique lie.
- Severe infection or sepsis.
- Signs of obstetric fistula.
- Unplanned hospitalization during pregnancy and after delivery for complications.
- Fetal demise.
- Symptoms or signs of life-threatening illness at any time during pregnancy or after delivery.

3 | RESULTS

Overall, 122 707 women were eligible for assessment of maternal near miss in the present study. At each site, more than 99% of the women enrolled in the MNH Registry before delivery and who delivered at 20 weeks of pregnancy or more were screened for near-miss events at delivery and at 42 days after delivery (data not shown). The total number of women with a 42-day near-miss evaluation was 122 408. Table 3 presents the number of women screened for maternal near miss per site. The delivery locations varied by site: for example, 13 251 (74.6%) of 17 769 deliveries in Nagpur occurred in hospital as compared with 1351 (9.7%) hospital births of the 13 962 total deliveries in the DRC site.

A positive response to at least one of the screening questions was recorded for 18 307 (15.0%) women, some of whom had more than one screening event. The total number of deliveries with one or more near-miss event, as defined by the Global Network system,

TABLE 3 Near-miss screening and cases of maternal near miss, by site.[a]

Outcomes	Overall (n=122 707)	DRC (n=13 962)	Zambia (n=12 887)	Guatemala (n=19 976)	Belagavi, India (n=21 915)	Pakistan (n=22 328)	Nagpur, India (n=17 769)	Kenya (n=13 870)
Delivery location								
Hospital	52 488 (42.9)	1351 (9.7)	3005 (23.6)	10 837 (54.3)	12 620 (57.6)	8281 (37.2)	13 251 (74.7)	3143 (22.7)
Clinic/health center	42 309 (34.6)	8918 (64.1)	7459 (58.5)	193 (1.0)	8344 (38.1)	6178 (27.8)	4399 (24.8)	6818 (49.3)
Home/other	27 557 (22.5)	3650 (26.2)	2285 (17.9)	8919 (44.7)	944 (4.3)	7799 (35.0)	88 (0.5)	3872 (28.0)
Near-miss events								
42 day near-miss outcome obtained	122 408 (99.8)	13 927 (99.7)	12 752 (99.0)	19 950 (99.9)	21 914 (100.0)	22 278 (99.8)	17 747 (99.9)	13 840 (99.8)
≥1 positive near-miss screening criterion	18 307 (15.0)	1086 (7.8)	776 (6.1)	3681 (18.5)	4655 (21.2)	4366 (19.6)	2687 (15.1)	1056 (7.6)
≥1 near-miss event	4866 (4.0)	521 (3.7)	167 (1.3)	1221 (6.1)	615 (2.8)	1830 (8.2)	79 (0.4)	433 (3.1)
≥1 near-miss event as % of positive screen	26.6	48.0	21.5	33.2	13.2	41.9	2.9	41.0
Outcomes								
Maternal death <42d	187	42	9	15	21	69	20	11
Live birth	120 593	13 637	12 827	19 712	21 548	21 604	17 541	13 724
Maternal deaths per 100 000 live births	155	308	70	76	97	319	114	80
Ratio of near miss to maternal mortality[b]	26:1	12:1	19:1	81:1	29:1	27:1	4:1	39:1

Abbreviation: DRC, Democratic Republic of the Congo.

[a]Values are given as absolute number or number (percentage) unless stated otherwise.

[b]Rounded to number of cases.

was 4866 (4.0% of all women screened). The frequency of positive screens for one or more near-miss screening criteria ranged from 6.1% in Zambia to 21.3% in Belagavi, India (Table 3). The percentage of women screened who had a near-miss event ranged from 0.4% in Nagpur, India, to 8.2% in Pakistan (Table 3). Overall, of the women with a positive screening for near miss, 26.6% (4866/18 307) were found to have a near-miss maternal event; at the different sites, this percentage ranged from 2.9% in Nagpur, India, to 48.0% in the DRC (Table 3). The maternal mortality ratio was 155 per 100 000 live births overall, and ranged from 70 per 100 000 live births in Zambia to 319 per 100 000 live births in Pakistan. The overall ratio of near miss to maternal death was 26:1, with the ratios at the individual sites ranging from 4:1 in Nagpur to 81:1 in Guatemala.

Of the 4866 women with near-miss events, 106 (2.2%) had a second near-miss event and thus 4972 separate near-miss events were evaluated in total. Of these, 4492 (90.3%) were identified around the time of delivery visit and 480 (9.7%) were identified at 42 days after delivery. Table 4 summarizes the incidence of near-miss events by positive screening criteria. The screening criteria that were positive at delivery that were most commonly associated with a near-miss event were those related to prepartum and postpartum hemorrhage, and to infection; breech presentation and obstructed labor had lower percentages of associated near-miss events. At 42 days, more than 50% of women meeting each screening criterion had a near-miss event.

Of the near-miss events, 78.6% (3907/4972) had one organ system involved, 16.2% (805/4972) had two systems involved, 3.6% (181/4972) had three systems involved, and 1.1% (53/4972) had between four and six organ systems involved. Figure 1 shows which organ systems were involved for the near-miss events. Hematologic events (mostly hemorrhage) were the most common, followed by infection-related events and cardiovascular events.

Table 5 summarizes the number of near-miss events associated with each positive near-miss criterion, in addition to the organ systems involved in each near-miss event. For the near-miss events that screened positive for obstructed labor, for example, the most common organ systems/factors involved were hematologic/coagulation, infection, and cardiovascular. For the women who screened positive for hypertensive disease and had a near-miss event, the cardiovascular system was most commonly involved. At 42 days after delivery, approximately half the cases of life-threatening illness or unplanned hospitalization with a near miss-event were infection-related (Table 5).

4 | DISCUSSION

By using newly developed screening methods, the present study found an incidence of maternal near miss of 4.0%. Overall, 15.0% of

TABLE 4 Global Network positive near-miss screening and proportion of screenings with a near-miss event.[a,b]

Maternal near-miss screening criterion	No. of women	Near-miss event	
		Yes	No
Near-miss screening with delivery outcome completed	18 696	4972	13 724
Obstructed/prolonged labor/failure to progress	6942	929 (13.4)	6013 (86.6)
Severe prepartum hemorrhage	1053	769 (73.0)	284 (27.0)
Severe postpartum hemorrhage	1514	1196 (79.0)	318 (21.0)
Evidence of hypertensive disease/severe pre-eclampsia/eclampsia	3066	1287 (42.0)	1779 (58.0)
Breech/transverse or oblique lie	2536	376 (14.8)	2160 (85.2)
Severe infection	1376	1037 (75.4)	339 (24.6)
Unplanned hospitalization	4449	1140 (25.6)	3309 (74.4)
Other symptoms of life-threatening illness in pregnancy/delivery	3943	1496 (37.9)	2447 (62.1)
Fetal death	2566	711 (27.7)	1855 (72.3)
Near-miss screening with 42-d follow-up completed	18 679	4955	13 724
Signs of obstetric fistula	22	14 (63.6)	8 (36.4)
Signs of severe infection/sepsis	541	293 (54.2)	248 (45.8)
Seizures	55	33 (60.0)	22 (40.0)
Postpartum hemorrhage	357	205 (57.4)	152 (42.6)
Hospitalized after delivery for a complication	595	298 (50.1)	297 (49.9)
Other symptoms of life-threatening illness up to 6-wk postpartum	735	405 (55.1)	330 (44.9)

[a]Values are given as number or number (percentage).
[b]Women could have more than one event (18 307 women with ≥1 event).

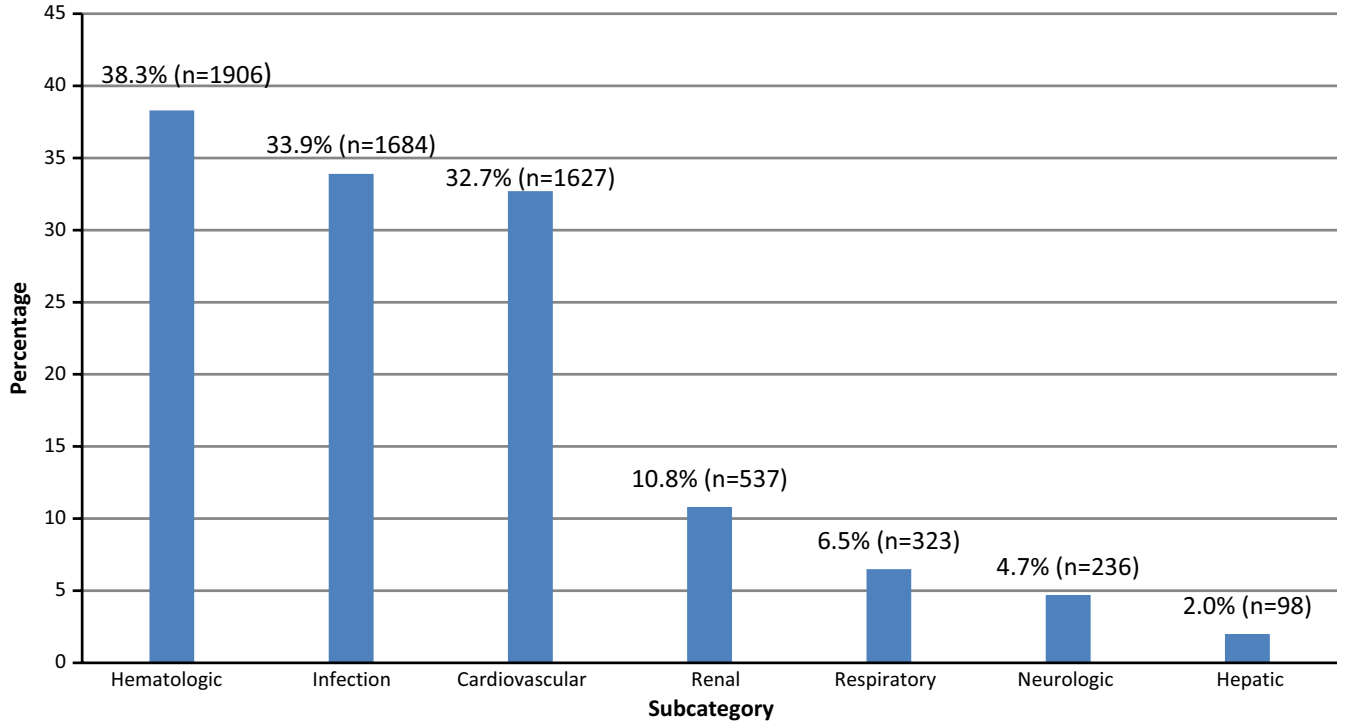

FIGURE 1 Near-miss events by subcategory (n=4972). More than one subcategory possible per event.

women screened were positive for one or more screening criteria, and 26.6% of those who screened positive had a near-miss event. Nearly 79% of those women with a near-miss event had only one event; conversely, 21% of those with a near-miss event had more than one.

In the Global Network sites, the maternal mortality ratios ranged from 70 per 100 000 live births in Zambia to 319 per 100 000 in Pakistan, with a mean of 155 per 100 000 live births overall. The incidence of near miss ranged from 0.4% in Nagpur, India, to 8.2% in Pakistan, with a mean of 4.0%. The ratio of near miss-events to maternal mortality was 26 to 1. Thus, for studies trying to show a significant improvement in outcomes via an intervention, the sample sizes needed to show a significant difference with maternal near miss as an outcome would be much smaller than if maternal mortality alone was the outcome.

Among the near-miss cases, those involving the hematologic (mostly hemorrhage) and cardiovascular systems and infection were the most common, followed by those involving the pulmonary, renal, and neurologic systems. Because near-miss cases are organized predominantly by organ system (infection is the exception), and because pre-eclampsia/eclampsia can involve nearly all organ systems, the present method cannot determine the percentage of near-miss cases related to pre-eclampsia or eclampsia. In the study population, however, only approximately 2.5% of women were diagnosed with a hypertensive disease including pre-eclampsia or eclampsia, although in most populations approximately 5% of women are likely to have this condition.[25] The estimate is low in many of the Global Network sites because the ability to diagnose this condition is limited. Many of the providers cannot or do not measure blood pressure or proteinuria; even if they do, it is not often measured in the third trimester when pre-eclampsia generally becomes apparent. Notably, the near-miss cases associated with pre-eclampsia/eclampsia were spread across many organ systems. Near-miss cases associated with other obstetric conditions, such as prolonged or obstructed labor, were also distributed across multiple organ systems.

In large population-based studies of maternal near miss, carefully reviewing each case to identify a near-miss event is impractical. For that reason, a screening method to identify women at risk for a near-miss event was evaluated in the present study. Several pregnancy complications were also reviewed to determine their ability to identify a near-miss event. Notably, 90.3% of near-miss events were recognized around the time of delivery, and only 9.7% of events were identified at 42 days postpartum. The percentage of positive screening criteria associated with a near-miss event around delivery ranged from obstructed labor (13.4%) and breech presentation (14.8%) to postpartum maternal hemorrhage (79.0%). For each of the criteria at 42 days after delivery, more than 50% of cases with a positive screen experienced a near-miss event.

The WHO near-miss system focuses on hospital-based deliveries in high-income countries and thus seems to have limited value in LMICs. To address this limitation, the WHO criteria were modified in the present study to focus on items that are more appropriate to low-resource settings, especially in areas where most women deliver at home or in health clinics. A similar modification was made by Nelissen et al.[9,26] for a facility-based study in a rural region in Tanzania.

The strengths of the present study include the large population and the fact that it evaluated population-based near miss and maternal mortality, including all delivery locations and not only hospital deliveries. The method, which includes screening criteria to identify women who should

TABLE 5 Global Network near-miss screening criteria met in near-miss cases and the organ systems involved.[a]

Maternal near-miss screening criterion[b]	No. of near-miss cases meeting screening criterion	Hematologic/ coagulation	Infection	Cardiovascular	Renal	Respiratory	Neurologic	Hepatic
During pregnancy or at delivery								
Obstructed/prolonged labor/failure to progress	929	347 (37.4)	335 (36.1)	305 (32.8)	110 (11.8)	68 (7.3)	45 (4.8)	20 (2.2)
Severe prepartum hemorrhage	769	644 (83.7)	121 (15.7)	129 (16.8)	127 (16.5)	29 (3.8)	19 (2.5)	10 (1.3)
Severe postpartum hemorrhage	1196	1021 (85.4)	163 (13.6)	222 (18.6)	235 (19.6)	59 (4.9)	30 (2.5)	11 (0.9)
Hypertensive disease/ severe pre-eclampsia/ eclampsia	1287	187 (14.5)	129 (10.0)	938 (72.9)	118 (9.2)	153 (11.9)	121 (9.4)	77 (6.0)
Breech/transverse or oblique lie	376	130 (34.6)	138 (36.7)	120 (31.9)	41 (10.9)	30 (8.0)	18 (4.8)	8 (2.1)
Severe infection	1037	181 (17.5)	941 (90.7)	131 (12.6)	55 (5.3)	68 (6.6)	48 (4.6)	19 (1.8)
Unplanned hospitalization	1140	312 (27.4)	279 (24.5)	632 (55.4)	166 (14.6)	120 (10.5)	70 (6.1)	23 (2.0)
Other symptoms of life-threatening illness in pregnancy/delivery	1496	628 (42.0)	447 (29.9)	544 (36.4)	207 (13.8)	58 (3.9)	102 (6.8)	52 (3.5)
Fetal death	711	322 (45.3)	308 (43.3)	174 (24.5)	82 (11.5)	43 (6.0)	37 (5.2)	18 (2.5)
42 d after delivery								
Signs of obstetric fistula	14	2 (14.3)	11 (78.6)	4 (28.6)	1 (7.1)	2 (14.3)	0	0
Signs of severe infection/ sepsis	293	47 (16.0)	256 (87.4)	50 (17.1)	25 (8.5)	14 (4.8)	13 (4.4)	8 (2.7)
Seizures	33	6 (18.2)	10 (30.3)	17 (51.5)	5 (15.2)	9 (27.3)	21 (63.6)	1 (3.0)
Postpartum hemorrhage	205	152 (74.1)	60 (29.3)	50 (24.4)	36 (17.6)	15 (7.3)	13 (6.3)	5 (2.4)
Hospitalized after delivery for a complication	298	110 (36.9)	163 (54.7)	72 (24.2)	49 (16.4)	21 (7.0)	25 (8.4)	7 (2.3)
Other symptoms of life-threatening illness up to 6 wk postpartum	405	163 (40.2)	208 (51.4)	93 (23.0)	53 (13.1)	35 (8.6)	34 (8.4)	9 (2.2)

[a]Values are given as number or number (percentage).
[b]Because more than one positive screening question might be associated with one event, the number of positive screening questions was higher than the number of near-miss cases.

be more closely assessed, should enable large populations to be evaluated for maternal near miss. Limitations include the wide variation in the rates of maternal near miss across the study sites. These wide ranges need further exploration to determine whether the differences are real or result from idiosyncrasies in reporting among the sites, despite the standard forms and instructions used for data collection. Similarly, large variations in maternal mortality were noted among the sites, and some rates were lower than would be anticipated from previously reported country data. Whether these lower rates are due to better care at the research sites or to unidentified maternal deaths is unknown.

In summary, preliminary results from a near-miss identification system designed for population-based studies in low-resource areas showed that both the percentage of deliveries classified as having a near-miss event and the organ systems most frequently involved were within the range of previously reported data. Whether focusing on maternal near miss rather than on maternal deaths will ultimately lead to an improvement in maternal morbidity and mortality remains unknown.

AUTHOR CONTRIBUTIONS

RLG, SS, JLM, AL, AT, MMw, EC, AG, LF, SG, BK, AP, FE, MSH, CLB, NFK, KMH, RJD, PLH, EAL, DDW, JMB, MMi, MB, MK-T, WAC, AHJ, and EMM developed the study protocol and monitored the study implementation. All authors participated in discussions related to the design of the study. SS, SA, AL, AT, MMw, EC, AG, LF, SG, BK, AP, FE, and PN implemented the study; JLM, DDW, and EMM conducted study analyses. RLG and EMM wrote the first draft of the manuscript with input from SS, JLM, AL, AT, MMw, EC, AG, LF, SG, BK, AP, FE, MSH, MB, CLB, NFK, KMH, RJD, PLH, EAL, DDW, JMB, MMi, MK-T, WAC, and AHJ. All authors reviewed and revised various drafts of the manuscript and approved the final version.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest.

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