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Incidence, causes and correlates of maternal near-miss morbidity: a multi-centre cross-sectional study

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Objective To explore the incidence and factors associated with maternal near-miss.

Design Cross-sectional study with an embedded case–control study.

Setting Three tertiary referral hospitals in southern Ghana.

Population All women admitted to study facilities with pregnancy-related complications or for birth.

Methods An adapted version of the WHO Maternal Near Miss Screening Tool was used to identify maternal near-miss cases. These were compared with unmatched controls (uncomplicated deliveries) in a ratio of 1:2.

Main outcome measures Incidence of maternal near-miss, maternal near-miss to maternal mortality ratio, and cause of and factors associated with maternal near-miss.

Results Out of 8433 live births, 288 maternal near-miss cases and 62 maternal deaths were identified. In all, 454 healthy controls were recruited for comparison. Maternal near-miss and maternal death incidence ratios were 34.2 (95% CI 30.2–38.1) and 7.4 (95% CI 5.5–9.2) per 1000 live births, respectively with a maternal near-miss to mortality ratio of 4.6:1. Cause of near-miss was pre-eclampsia/eclampsia (41.0%), haemorrhage (12.2%), maternal sepsis (11.1%) and ruptured uterus (4.2%). A major factor associated with maternal near-miss was maternal fever within the 7 days before birth (OR 5.95, 95%CI 3.754–9.424). Spontaneous onset of labour was protective against near-miss (OR 0.09 95% CI 0.057–0.141).

Conclusion For every maternal death, there were nearly five maternal near-misses. Women having a fever in the 7 days before delivery were six times more likely to experience a near-miss than women not having fever.

Keywords Maternal mortality, maternal near-miss, maternal near-miss indicators.

Tweetable abstract Maternal near-miss exceeds maternal death by 5:1, with the leading cause of maternal near-miss was pre-eclampsia/eclampsia.

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Introduction

Low-income countries, especially those in sub-Saharan Africa, continue to bear a disproportionate burden of maternal morbidity and mortality.[1] Ghana is one of the countries in sub-Saharan Africa that failed to reach the millennium development goal for maternal health, which was a target of no more than 185 maternal deaths per 100 000 live births. Ghana ended 2015 with a maternal mortality ratio of nearly twice the target: 350 per 100 000 live births.[2] Pregnant women in Ghana continue to die from largely preventable causes, including haemorrhage, hypertensive diseases and complications related to termination of pregnancy.[3–7] These mortality figures are only a

small part of the story. For every woman who dies, there are many others who survive severe, life-threatening complications that may have long-lasting sequelae.[8–10]

Morbidity and mortality can be seen as a continuum. Maternal health can be described as ranging from normal pregnancy with no complications at one end through mild non-life-threatening complications and life-threatening complications, to death at the other end of the continuum. As such, a maternal near-miss has been defined as 'a woman who nearly died from a life-threatening complication of pregnancy, delivery, or up to 42 days after termination of pregnancy but survived'.[11] Depending on the context and the specific criteria used, the incidence of maternal near-miss ranges from 0.6% to > 30% of all live births.[12] There has been one previous study from Ghana, which estimated that maternal near-misses outnumbered mortality at a ratio of about 3:1 in a single setting.[7] Hence, the true incidence of maternal near-miss in Ghana is not known; in addition, the causes of, as well as factors associated with, maternal near-miss are not well understood. This is in stark contrast to the well-developed literature describing the causes of maternal mortality.[3–7]

As mortality events become less common, maternal near-misses are likely to become an increasingly important metric by which quality of care can be measured. We explored maternal near-misses at three of Ghana's four tertiary-care obstetric units to identify the burden, cause of, as well as factors associated with, maternal near-miss morbidity.

The primary aim of this study was to estimate the incidence of maternal near-miss morbidity per 1000 live births. The secondary aims were (i) to determine the maternal near-miss to mortality ratio, and (ii) to use an embedded case–control study to determine factors associated with maternal near-miss.

Method

Study design

We performed a multi-centre, cross-sectional study with an embedded case–control study.

Setting

This study was conducted at three tertiary referral hospitals in southern Ghana over a 4-month period (1 April to 31 July 2015). The study sites were the maternal and neonatal units of the Korle-bu Teaching Hospital (KBTH) in Accra, and the Cape Coast Teaching Hospital (CCTH) and Komfo Anokye Teaching Hospital (KATH) in Kumasi.

The KBTH is located in Accra, the capital city of Ghana, with a population of about 3.2 million.[13] It is the largest referral hospital in Ghana, overseeing approximately 11 000 deliveries annually and serving as the teaching hospital for the School of Medicine and Dentistry, University of Ghana. KATH is located in Kumasi, the second largest city in Ghana, with a population of about 2 million.[13] It serves as the referral centre for most of mid-Ghana, overseeing approximately 11 000 deliveries per year, and serving as the teaching hospital affiliated with the Kwame Nkrumah University of Science and Technology School of Medical Sciences. CCTH is located to the west of Accra at the coastal town of Cape Coast, about 100 miles from Accra. It serves as the main referral hospital for most of the rural Central and parts of the Western region of Ghana, overseeing approximately 2800 deliveries per year and serving as the teaching hospital of the University of Cape Coast, School of Medical Sciences.

Determining the number of live births

Summary statistics were collected reflecting the total number of deliveries, live births and maternal deaths for the study period from each of the three participating hospitals' records. In addition, trained research assistants reviewed all admission and delivery records as well as caesarean operation record books to record the total number of deliveries during the study period.

Identifying and classifying maternal near-misses

Each day, research assistants reviewed the admission and delivery records for all pregnant women aged 18–49 years who delivered at one of the three study sites or were referred with pregnancy or delivery-related complications up to 42 days after termination of the pregnancy. Complications were defined as any indication in the medical record that a woman had experienced a pregnancy- or delivery-related complication (haemorrhage; pre-eclampsia, eclampsia, or other hypertensive disorder; premature rupture of membranes; premature delivery; oligohydramnios; gestational diabetes; miscarriage; complication from termination of pregnancy; obstructed labour/failure to progress; malposition; shoulder dystocia; emergency caesarean section; placenta praevia; or any other noted pregnancy or delivery complication). This list of complications was used across all three study sites.

All records were screened for eligibility using the modified version of the WHO Maternal Near Miss Screening Tool,[14] which was simplified for use in settings without all of the laboratory tests and intervention procedures available as included in the full WHO instrument (see Supplementary material, Appendix S1). Participants were assessed for the presence of specific symptom-based criteria (such as severe haemorrhage, severe pre-eclampsia, eclampsia, sepsis or systemic infection or ruptured uterus, assessed by attending obstetrician/gynaecologist), intervention-based criteria (such as use of blood products, laparotomy or admission to the intensive care unit) or organ dysfunction-based criteria

(such as cardiovascular, respiratory, renal, haematological, hepatic, neurological or uterine dysfunction). A positive response to any of the above qualified a woman as a 'near-miss'. This classification was double-checked by an attending physician (consultant) at each study location. Women were excluded if they died during childbirth or were unwilling to provide consent. Incidental maternal deaths would have been excluded; however, no incidental maternal deaths were identified during the study period.

Identification of 'controls' for embedded case–control study

As described above, research assistants went through each medical record and completed a unique screening form for each patient, indicating which of the near-miss criteria were applicable. If the screening form indicated that none of the criteria above for definition of complicated pregnancy or delivery was met, the patient was determined to be 'uncomplicated' and hence qualified as a 'control' for the purpose of this study. For each near-miss 'case' identified, the next two uncomplicated normal vaginal deliveries were selected as controls.

Identification of cause of near-miss

The primary cause of each case of maternal near-miss was determined by physician review to determine primary and contributing factors associated with maternal near-miss. Primary cause of maternal near-miss was based on the WHO International Classification of Diseases, 10th revision,[15] with contributing conditions of anaemia, HIV infection, previous caesarean section, prolonged/obstructed labour, sickle cell anaemia, and sickle cell crisis. Each case was then reviewed by one of the study investigators to verify cause of near-miss.

A Qualtrix-based (Qualtrics, Provo, UT, USA), structured, interviewer-administered questionnaire was used to record demographic data (including reported material assets, which were combined to calculate a wealth index), pregnancy-related data and delivery outcome information. Clinical and laboratory data were also abstracted from patients' medical records.

Data analysis

Data were imported and analysed with Stata version 13.1 (College Station, TX, USA). Study data were compared against official hospital tallies to validate the number of deliveries and live births recorded for each month. Maternal near-miss incidence was calculated by dividing the number of maternal near-misses recorded by the number of live births recorded, in keeping with the predominant method in the existing literature.[12]

Frequencies and basic descriptive statistics were calculated for all variables, including proportions, means and standard deviations. Bi-variate statistics and test of associations were performed with Pearson chi-square test for categorical variables and Student's t test for continuous variables. Assuming an initial α of 0.05, Bonferroni's correction was conducted to identify a level of significance of $P < 0.002$ to account for multiple comparisons. A backward stepwise multiple logistic regression was performed with covariates that were significant in the bivariate analysis to determine the odds ratio (OR) and 95% CI for maternal near-miss. The resulting model was re-run using a generalised linear mixed model with site treated as a random effect to account for differences across sites. Coefficients were exponentiated to allow for reporting of odds ratios.

Ethical approval

This study and its components were reviewed and approved by the institutional review boards of University of Ghana for KBTH site (MS-Et/M.7 – P4.5/214-2015 on 10 March 2015), University of Cape Coast for CCTH (UCCIRB/EXT/2015/02 on 8 April 2015) and at the KATH (CHRPE on 25 January 2015) as well as the University of Michigan (HUM00097103 on 16 February 2015).

Results

During the study period, a total of 8433 live births were recorded across the three study centres, and a total of 288 women were identified to be maternal near-misses (Table 1), yielding an overall maternal near-miss incidence of 3.42%, or an incidence ratio of 34.2 maternal near-misses per 1000 live births (95% CI 30.2–38.1). (Table 2) There were 79 (27.5%), 120 (41.7%) and 89 (30.8%) near-miss cases at study sites I (CCTH), II (KATH) and III (KBTH), respectively. During the same period, a total of 62 maternal deaths were recorded, yielding a maternal mortality incidence ratio of 7.35 (95% CI 5.5–9.2) per 1000 live births. This translates to a near-miss to maternal mortality ratio of 4.6:1 (95% CI 3.4–6.0).

Table 3 illustrates the primary and underlying causes of maternal near-misses overall, as well as by site. The primary cause of maternal near-miss was severe pre-eclampsia/eclampsia (n = 110, 38.2%), severe haemorrhage (n = 35, 12.1%), ruptured uterus (n = 12, 4.2%) and maternal sepsis (n = 10, 3.6%). The secondary or contributing causes of maternal near-miss were as follows: anaemia (n = 81, 28.1%), hypertensive disorder (n = 78, 27.1%), infection during pregnancy (n = 49, 17.0%), obstructed labour (n = 39, 13.5%) or other obstetric complications (n = 41, 14.2%). The distributions of these causes were not consistent: site I (CCTH) contributed a higher proportion of anaemia and pregnancy-related infections than the other two sites; site II (KATH) had much lower percentages of women with pre-eclampsia and eclampsia; and site III

(KBTH) contributed a disproportionate number of women with pre-eclampsia and eclampsia as well as hypertensive disorders (see Table 3). A total of 454 women were recruited as healthy controls. The distribution of controls was 149 (32.8%) from site I, 172 (37.9%) from site II and 133 (29.3%) from site III. Table 4 illustrates the socio-demographic and health-related variables for both cases and controls. There were no significant differences between cases and controls in terms of any of the socio-demographic variables measured, including age, maternal and partner's education, marital status, wealth, or health insurance status. In terms of health-related variables, maternal near-miss was associated with previous caesarean section, non-spontaneous onset of labour for the index birth, multiple births, lower infant birthweight, and fever < 7 days before delivery. Mothers who experienced a near-miss were less likely to have delivered a live infant, and they were more likely to have been referred from other facilities to the tertiary centres for care during labour and/or delivery.

Table 5 illustrates the results of the generalised linear mixed model with site as a random effect. Previous caesarean section, multiple pregnancy and whether the baby was alive at birth were not significant in multivariate analyses and were removed one-by-one to yield the final model shown in Table 5. This model shows that women who experienced a fever within the 7 days before birth were nearly six times more likely to have a maternal near-miss than women who did not have a fever in the days leading up to birth (OR 5.94, 95% CI 3.65–9.68, $P < 0.001$). Women who had been referred from another hospital were 1.5 times more likely to experience a near-miss than women who had not been referred (OR 1.5, 95% CI 0.99–2.34, $P < 0.054$); however, this finding was not statistically significant. Women whose labour began spontaneously were significantly less likely to experience a maternal near-miss than those women whose labour did not start spontaneously. Women with a maternal near-miss were more likely to have a baby with a lower birthweight than controls.

Table 1. Identification of maternal near-miss in three tertiary hospitals in southern Ghana

Symptom-based criteria [yes to any of the following: severe haemorrhage (n = 19), severe pre-eclampsia (n = 30), eclampsia (n = 84), sepsis or systemic infection (n = 12), ruptured uterus (n = 1)]	146 (19.7)
Intervention-based criteria [yes to any of the following: use of blood products (n = 98), laparotomy (n = 67), admission to intensive care unit (n = 102)]	189 (25.5)
Organ-dysfunction-based criteria [yes to specific indicators for cardiovascular (n = 28), respiratory (n = 23), renal (n = 5), haematological (n = 16), hepatic (n = 4), neurological (n = 6) and uterine dysfunction (n = 5)]	60 (8.1)
Met no criteria	454 (61.2)
Met one category of criteria	202 (27.22)
Met two categories of criteria	64 (8.6)
Met three categories of criteria	22 (3.0)

Discussion

Main findings

This study assessed cases of maternal near-miss across three tertiary care centres in southern Ghana, finding an overall incidence of 34.2 per 1000 live births. The overall maternal near-miss-mortality ratio was 4.6:1 with slight variability across sites. We found that, overall, severe pre-eclampsia/eclampsia, haemorrhage, uterine rupture and sepsis were the leading causes of maternal near-miss, although this varied by site. This is in line with the leading causes of maternal mortality in Ghana, which include termination of pregnancy (19.6%), postpartum haemorrhage (19.2%), hypertensive disorders (9.1%), obstructed labour (7.3%) and sepsis (6.4%).[16] The single strongest factor associated with a maternal near-miss was fever within the 7 days

Table 2. Maternal near-miss incidence and incidence ratio at three tertiary hospitals

	Study sites			Total
	I	II	III	
Number of live births	1149	3596	3688	8433
Number of maternal deaths	11	32	19	62
Number of maternal near-miss cases identified	79	120	89	288
Maternal near-miss incidence (per 1000 live births; 95% CI)	68.7 (53.6–83.9)	33.4 (27.4–39.3)	24.1 (19.1–29.1)	34.2 (30.2–38.1)
Maternal mortality per 1000 live births (95% CI)	9.5 (3.9–15.2)	8.9 (5.8–11.9)	5.5 (2.8–7.4)	7.4 (5.5–9.2)
Maternal near-miss : mortality ratio (95% CI)	7.2:1 (3.8–13.6)	3.8:1 (2.5–5.5)	4.4:1 (2.8–7.7)	4.6:1 (3.4–6.0)

Table 3. Primary and contributing causes of maternal near-misses overall and by study site

	Study sites			
	I (*n* = 79) *n* (%)	II (*n* = 120) *n* (%)	III (*n* = 89) *n* (%)	Overall (*n* = 288) *n* (%)
Primary causes				
Pre-eclampsia and eclampsia	38 (48.1)	9 (7.5)	63 (70.8)	110 (38.2)
Haemorrhage	8 (10.1)	22 (18.3)	5 (5.6)	35 (12.1)
Ruptured uterus	5 (6.3)	5 (4.2)	2 (2.3)	12 (4.2)
Sepsis	6 (7.6)	3 (2.5)	1 (1.2)	10 (3.8)
Underlying or contributing causes				
Anaemia	45 (56.9)	15 (12.5)	21 (23.6)	81 (28.1)
Hypertensive disorders	9 (11.4)	8 (6.7)	61 (68.5)	78 (27.1)
Infection during pregnancy	45 (57.0)	1 (0.8)	3 (3.4)	49 (17.0)
Obstructed labour	13 (16.5)	19 (15.8)	7 (7.9)	39 (13.5)
Other obstetric complications	2 (2.5)	4 (3.3)	35 (39.3)	41 (14.2)

I: Cape Coast Teaching Hospital (CCTH)
II: Komfo Anokye Teaching Hospital (KATH)
III: Korle-Bu Teaching Hospital (KBTH)

Table 4. Socio-demographic and health-related variables for maternal near-miss cases and controls at three tertiary hospitals in southern Ghana

Variable name (Total *n* = 742)	Cases (*n* = 288) Mean (SD)	Controls (*n* = 454) Mean (SD)	*t*-test statistic (*P*-value)
Maternal age (*n* = 445)	29.7 (6.4)	28.8 (6.3)	−1.47 (0.15)
Maternal education (years) (*n* = 447)	8.9 (4.0)	8.9 (4.4)	−0.11 (0.91)
Husband's education (years) (*n* = 351)	10.5 (3.9)	10.5 (3.8)	0.21 (0.83)
Assets (on 0–16 point scale)* (*n* = 327)	9.1 (3.4)	9.2 (3.4)	0.31 (0.75)
Mean number of prior births (*n* = 732)	1.7 (1.7)	1.7 (1.7)	0.11 (0.91)
Number of antenatal care visits (*n* = 351)	6.7 (2.4)	6.9 (2.6)	0.83 (0.40)
Infant birthweight (kg) (*n* = 678)	2.653 (0.803)	3.080 (0.597	7.91 **(<0.001)**†
	Cases % (*n*)	**Controls % (*n*)**	**Chi-square statistic (*P* value)**
Married (*n* = 742)	38.5 (111)	43.4 (197)	1.71 (0.19)
Polygamous marriage (*n* = 742)	3.5 (10)	1.8 (8)	2.17 (0.14)
Has national health insurance (*n* = 447)	93.6 (147)	96.2 (279)	1.51 (0.22)
Delivered in a healthcare facility (*n* = 444)	99.4 (154)	98.9 (286)	0.17 (0.67)
Previous caesarean section (*n* = 740)	28.8 (83)	13.7 (62)	25.46 **(<0.001)**†
Mode of delivery index pregnancy (*n* = 742)			3.4 (0.18)
Vaginal delivery	86.5 (249)	89.7 (407)	
Caesarean section	8.7 (25)	7.9 (36)	
Spontaneous labour (*n* = 712)	47.4 (129)	89.09 (392)	149.4 **(<0.001)**†
Fever < 7 days before labour (*n* = 705)	39.1 (104)	13.4 (59)	61.3 **(<0.001)**†
Anaemia during pregnancy (*n* = 702)	35.9 (95)	33.9 (148)	0.04 (0.85)
Multiple pregnancy (*n* = 726)	7.1 (20)	3.8 (17)	3.72 (0.05)
Live infant at birth (*n* = 715)	91.1 (255)	97.2 (423)	13.2 **(<0.001)**†
Referred from other healthcare facility (*n* = 731)	49.1 (139)	35.9 (161)	12.4 **(<0.001)**†

*Assets include aggregate list of 16 different material goods owned or available within the household, including car/truck, motorcycle, bicycle, electricity, solar light, refrigerator, television, DVD/VCR, radio, sewing machine, stereo system, electric/box iron, fan, mobile phone, electric/gas cooking stove, donkey cart/push truck, kerosene stove, personal computer.
†Factors associated with maternal near-miss

Table 5. Generalised linear mixed model (with site as a random effect) for predictors of maternal near-miss at three tertiary hospitals in southern Ghana

Variable	Odds ratio	Standard error	*Z*	*P* value	95% CI
Infant birthweight	0.99	0.0001	−5.07	**<0.001***	0.998–0.999
Spontaneous onset of labour	0.09	0.245	−9.81	**<0.001***	0.056–0.146
Fever in 7 days before delivery	5.94	0.248	7.16	**<0.001***	3.649–9.681
Referred from another facility	1.52	0.530	1.93	0.054	0.992–2.344

*Significant predictors of maternal near-miss in a negative binomial regression.

leading up to birth. Women who reported experiencing a fever in the days before delivery were nearly six times more likely to experience a near-miss than women who did not have a fever, even after controlling for site differences.

Implications for practice

This study suggests that there is a need to screen for, and pay additional attention to, women who report a fever in the 7 days leading up to delivery to avert their progression to potentially life-threatening complications. In view of the known relationship between maternal near-miss and mortality it may be helpful to investigate how febrile morbidity contributes to maternal near-miss, especially as the two identified leading causes of maternal near-miss were pre-eclampsia/eclampsia and haemorrhage.

Strengths and limitations of the study

This study has several strengths. First, data were collected at three tertiary care centres in Ghana, ensuring diversity in our sample. We also collected data prospectively, not relying upon retrospective chart reviews. We included socio-demographic factors not typically included in clinical studies. However, despite its strengths, our data collection window was limited and so we cannot explore seasonal or year-to-year differences. We also did not collect quality-of-care indicators that may have helped contextualise differences found across sites in terms of variability in the number and causes of maternal near-misses.

Interpretation

This study adds to the literature in several ways. In Ghana, most previous studies have focused on mortality with few studies evaluating morbidity.[3–7] We found the incidence of maternal near-misses across three tertiary care centres dispersed over a wide geographic area to be higher than that previously reported from one hospital in Accra, which identified 94 maternal near-misses out of 3206 live births, or a maternal near-miss incidence of 29.3 per 1000 live births.[7] The maternal near-miss to mortality ratio in our study (4.6:1) is almost twice the 2.5:1 reported despite using the same maternal near-miss criteria in both studies. This observed difference may be due to the inclusion of two other tertiary care centres in Ghana that are outside the capital city. This ratio is also closer to the 5.6:1 reported by some authors from India.[16] Cause of death data were not complete for the maternal deaths that occurred in each of the participating healthcare facilities, hence comparison of cause of death and cause of near-miss within each facility or across the study sites was not possible. However, we obtained national-level cause of maternal death data from the Global Burden of Disease Study,[17] allowing us to compare the leading causes of maternal death in Ghana with the leading primary causes of maternal near-miss. We found the leading causes of maternal near-misses at three of the four largest hospitals in the country to be fairly consistent with the leading causes of maternal mortality in Ghana, suggesting that review of cases of maternal near-miss are indeed a viable alternative to review of maternal mortality cases. With decreasing maternal deaths in many places around the world, maternal near-miss identification and maternal near-miss audit are becoming more useful methods to review the quality of care provided.

One interesting aspect of our findings includes the lack of significant association between socio-demographic factors and maternal near-miss. Maternal age, maternal education, husband's education, household size, wealth, parity, gravidity, religion and marital status were not associated with maternal near-misses. This is different from other studies, which found age,[18] gravidity,[19] maternal education[19] and partner's education[20] to be significantly associated with maternal near-misses. Notably, one study in Brazil found that social and demographic characteristics of the mother were not directly linked to maternal near-miss status, although such factors were linked to differences in care seeking, which was then in turn linked to near-miss status.[21] In our study, care seeking – e.g. number of antenatal visits – was not significantly different between cases of near-miss and controls. One possible explanation of the limited role of social factors in our study is that we compared healthy controls with near-misses, rather than comparing near-misses with those women who died. It is possible that women who experience a near-miss are more similar to healthy controls in terms of socio-demographic

characteristics than they are to women who do not survive a life-threatening complication.

Conclusion

In conclusion, this study identified nearly 300 cases of maternal near-miss, reflecting a maternal near-miss incidence of approximately 34 per 1000 live births with approximately five cases of maternal near-miss for every maternal death. Near misses in our study were caused predominantly by hypertensive disorders, haemorrhage, uterine rupture and sepsis, with the single largest correlate in a multivariate model being the presence of fever in the 7 days before delivery. Spontaneous onset of labour was also associated with a lower risk of maternal near-miss.

Disclosure of interests

None declared. Completed disclosure of interests form available to view online as supporting information.

Contribution to authorship

SAO, AB, AJB, RMA and CAM conceived the idea and developed the research question, SAO, AB, AJB, YB, JAA, CAT and SO conducted the experiment to obtain the data; SAO, AB, AJB and CAM analysed the data, SAO and CAM wrote the first draft of the manuscript, and all authors reviewed and approved the final manuscript before submission.

Details of ethics approval

This study and its components were reviewed and approved by the institutional review boards of University of Ghana for KBTH site (MS-Et/M.7 – P4.5/214-2015 on 10 March 2015), University of Cape Coast for CCTH (UCCIRB/EXT/2015/02 on 8 April 2015) and at the KATH (CHRPE/AP/021/15 on 25 January 2015) as well as the University of Michigan (HUM00097103 on 16 February 2015), which was the data coordinating centre.

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Supporting Information

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Appendix S1. Maternal near-miss tool. ■

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Maternal near-miss morbidity: is this evidence of maternal health quality in sub-Saharan Africa?

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The article by Samuel Oppong et al. makes interesting reading (Oppong et al. *BJOG* 2019; 126:755–62). It describes a study carried out in three tertiary referral hospitals in southern Ghana that investigated the incidence of and factors associated with maternal near-miss morbidity. The study used the WHO Maternal Near-Miss Screening tool to identify maternal near misses among 8433 live births and reported a maternal near-miss rate of 34.2 per 1000 live births compared with a maternal mortality ratio of 740 per 100 000 live births. This implied a near miss to mortality ratio of nearly 5 : 1, indicating that nearly five deaths are averted for every reported maternal death. The authors compared the results with unmatched controls with uncomplicated deliveries and concluded that women experiencing fever within 7 days of delivery were six times more likely to experience a near miss compared with women without fever.

Although this study is novel and is one of a few large studies that report near-miss maternal morbidity in sub-Saharan Africa, it can be debated whether a better control would not have been women with similar complications who died. Alternatively, the authors could have statistically controlled for potential confounders to identify how mortality was prevented among near misses.

Nevertheless, the study is important for two main reasons. First, using the three-delay model proposed by Thaddaeus and Maine (*Social Sci Med* 1994;36:1091–110), it suggests that although women may experience delays in accessing referral facilities, concentrating efforts on complications through emergency obstetric care can be effective in preventing maternal deaths. This study is a salutary reminder to health workers and policy-makers in sub-Saharan Africa that much can be achieved if there is high-level willingness and determination to prevent maternal deaths.

Second, the reported higher incidence of maternal near misses in this study suggests improved quality of maternal health care in the referral hospitals. Previous studies report higher case fatality rates from obstetric complications in sub-Saharan Africa. Although this study was not designed to document quality of care in the referral facilities, the reported high rates of near misses suggests lower case fatalities associated with complications, and therefore improved quality of emergency obstetric care.

To date, near misses have not been used consistently as a measure of quality of care in regions with high rates of maternal mortality. We suggest that the incidence of near misses is a key indicator of quality of care, because it accounts for all components of emergency obstetric care in referral facilities. Also, any near miss is likely to share risk factors with maternal deaths, so indicating what can be done to avert more deaths. Furthermore, it should motivate providers and policy-makers to take concrete steps to aggressively manage women with severe complications. This is also a call for larger studies that use appropriate controls to enable the identification of specific actions that lead to prevention of maternal deaths in women experiencing severe pregnancy complications.

Disclosure of interest

Friday Okonofua was a reviewer of the original article. Completed disclosure of interests form available to view online as supporting information. ■