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Determinants of maternal near-miss among women admitted to public hospitals in the Hadiya zone, central Ethiopia: a case-control study

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Informed consent: participants in the study provided verbal informed consent. The goal and purpose of the study, as well as the respondents' right to withdraw from the study at any time without compromising their hospital care, were explained to the participants. An anonymous questionnaire was used to ensure information confidentiality, and de-identified and de-linked data was kept in a safe place.

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Abstract

One of the Sustainable Development Goals of the United Nations is to bring the global maternal mortality ratio down to less than 70 per 100,000 live births by 2030. Therefore, pinpointing the factors that influence maternal near-misses would help expedite the accomplishment of this goal. Studies on these topics are, nevertheless, scarce in the Hadiya zone and throughout Ethiopia as a whole. Therefore, the

purpose of this study was to determine the factors that contribute to maternal near-misses among women who are admitted to public hospital maternity wards in the Hadiya zone in central Ethiopia. A facility-based, unmatched case-control study was conducted from February 17 to August 16, 2019. The study covered all secondary and tertiary public healthcare facilities in the Hadiya zone, which includes three district hospitals and one referral hospital offering comprehensive emergency obstetric care services. The study included 279 women in total (70 cases and 209 controls). Mothers who had had a near-miss were the cases, and mothers who had not had one were the controls. The Statistical Package for Social Sciences version 24 was used to analyze the data, and the multivariable binary logistic regression model was used to control confounders. The odds ratios (OR) and 95% confidence intervals (CI) were used to determine statistical significance at a p-value of less than 0.05. Living in a rural area [adjusted OR (AOR)=3.16; 95% CI: 1.62, 6.16], no birth preparedness (AOR=3.50; 95% CI: 1.66, 7.41), ever gave birth by cesarean section (AOR=3.68; 95% CI: 1.63, 8.31), previous history of hypertension (AOR=3.69; 95% CI:1.52, 8.96), and poor knowledge of pregnancy danger signs (AOR=3.15; 95% CI: 1.32, 7.52) were all determinants of maternal near-miss. Thus, strengthened public health and clinical interventions in these arenas need to prioritize rural women and women with a previous history of hypertension.

Introduction

Despite a 44% decrease in the maternal mortality ratio since 1990, ending preventable maternal death continues to be one of the world's most pressing challenges. Even though this is a notable improvement that demonstrates what is possible with continued effort, the world fell short of the 75% reduction target set by Millennium Development Goal 5.[1] Maternal deaths are uncommon in terms of absolute numbers per center, despite the high maternal mortality ratios in many resource-poor settings. As a result, there is less statistical power available for research to examine potential risk factors and contextual determinants.[2] Because maternal near-misses (MNM) occur more frequently than maternal deaths, in this case, they could be used as a stand-in for maternal deaths to assess the quality of obstetric care in specific healthcare facilities.[3,4] Moreover, it presents a favorable prospect for gathering data because women themselves can serve as information sources.[5] The World Health Organization (WHO) requested more research on MNM in light of these facts.[6,7] MNM is defined by the WHO as "a woman who nearly died but survived a complication that occurred during pregnancy, childbirth, or within 42 days of termination of pregnancy". Using a system that categorizes women based on serious (possibly) life-threatening conditions, the WHO suggests the "MNM approach" as a way to track and enhance the standard of obstetric care. Three different types of criteria are used to base the classification: disease-, intervention-, and organ dysfunction-based criteria.[7] Refined disease-based criteria are recommended as a result of a study that was carried out to validate the WHO MNM tool. It was found that using only organ dysfunction-based criteria may result in the underreporting of severe maternal outcomes, particularly in places with limited resources.[8] Because advanced laboratory tests needed for organ dysfunction were scarce in study settings, this study used a refined version of the WHO MNM tool tailored for sub-Saharan Africa.[9]

Prevalence and a nation's level of development appear to be correlated oppositely. Pregnant women who give birth in hospitals in resource-poor settings experience MNM at a rate of 4-8%, compared to 1% in developed countries, according to disease-specific criteria.[3] MNM had an incidence/prevalence ratio ranging from 1.1% to 10.1%, mainly in sub-Saharan Africa.[10] In Ethiopia, where the government uses a variety of tactics, such as providing free maternity care, to try and reduce severe maternal outcomes, the overall near-miss rate was 9079 per 100,000 live births.[11,12]

In the past 20 years, the idea of an MNM has been investigated in maternal health as a supplement to maternal death.[13] Despite noting factors, limited studies have been done on MNM in Ethiopia. A lot of those studies frequently used hospital records, which are unlikely to fully capture the socioeconomic and other factors from primary sources that are responsible for MNM.[6,14-17] The current study attempts to close the existing gap. Furthermore, Ethiopia, a country with a high maternal mortality ratio (412 per 100,000 live births), has seen only modest progress in reducing maternal mortality. The situation necessitated quick fixes to accelerate the Sustainable Development Goal of the United Nations of bringing the maternal mortality ratio below 70 per 100,000 live births by 2030.[7,18,19] To take appropriate action at the community and health system level, this study will aid in identifying the contributing factors to maternal deaths. Therefore, the purpose of this study is to determine the factors that contribute to MNM among women who are admitted to public hospital maternity wards in the Hadiya zone in central Ethiopia.

Materials and Methods

Study design

A facility-based, unmatched case-control study was carried out.

Study setting and period

The Hadiya zone, one of the central Ethiopia Regional State administrative zones, served as the study's site. In 2018, the population of the Hadiya zone, which spans 3542.66 km^2, was 1,650,104 (820,102 males, 830,002 females, and 384,474 women of childbearing age). There are four town administrations and thirteen districts in the zone. The capital of the Hadiya zone was Hossana, and it was situated 230 km southwest of Ethiopia's capital, Addis Ababa. The study covered all four hospitals in the zone (three district hospitals and one referral hospital). The names of these hospitals were Shone Primary Hospital, Ginbecho Primary Hospital, Homecho Primary Hospital, and Wachamo University Nigist Eleni Mohamed Memorial Referral Hospital. They were all offering comprehensive emergency obstetric care services. The three district hospitals were situated in semi-urban areas, while the referral hospital was situated in an urban area. Rural health centers are connected to district hospitals and referral hospitals *via* referral linkage. The study was carried out from February 17 to August 16, 2019.

Participants

Selection of cases

Women who met at least one of the potentially fatal criteria listed in the modified sub-Saharan Africa MNM tool,[9] and who are pregnant, in labor, have given birth, or have aborted up to 42 days ago and were admitted to the obstetrics and gynecology wards and/or obstetric intensive care units of the study hospitals were selected as cases (Table 1).[9]

Selection of controls

Selected mothers who were pregnant, *intrapartum*, or *postpartum* up to 42 days ago and who were admitted to the same study hospitals' obstetrics and gynecology wards as cases with normal obstetric outcomes (normal vaginal delivery or women with mild to moderate obstetric complications) were selected as controls. Conditions other than near-miss incidents that were associated with pregnancy were classified as mild to moderate complications.[17]

Exclusion criteria

Records missing relevant information to declare a case and ongoing communication difficulties were the exclusion criteria taken into consideration. However, all mothers did not meet the requirements for exclusion.

Study variables and measurement

Outcome variable

The outcome variable was the MNM. A woman admitted to a public hospital in the Hadiya zone was labeled as "yes" if she met at least one of the requirements listed in the modified Sub-Saharan Africa MNM tool and "no" if she did not (Table 1).[9] One doctor from each hospital who was hired as a supervisor declared the diagnosis of these life-threatening conditions from the client records upon each woman's admission each day to identify eligible cases. Trained midwives then conducted the interviews using checklists and pre-coded questionnaires.

Exposure variables

The study evaluated the factors that were accountable for the incidence of MNM incidents. These exposure variables included socio-demographic factors [(age, residence (rural/urban), marital status, educational level, maternal occupation, monthly income)]; obstetric and reproductive health factors (age at first pregnancy, birth interval, gravidity, parity, antenatal care (ANC), knowledge of danger signs, cesarean section (C/S), previous abortion, multiple pregnancies, history of stillbirth, previous and/or current pregnancy complications, place and attendant of current delivery, birth preparedness, female genital mutilation, contraception, and maternity waiting for home utilization); pre-existing medical illnesses (previous hypertension, previous anemia, history of cardiac problems, history of diabetes mellitus, and history of renal disease); and delays (first delay, second delay, third delay).

ANC was measured: when a woman who had at least one visit was considered to have ANC. The second delay, or the time it took to get to the health facility, was measured using the Ethiopian travel time standard and categorized as taking <2 hours or >2 hours.[20] The first and third delays were measured in hours and/or minutes. The first delay, which was the delay in seeking medical attention, was categorized into two categories: <24 hours and >24 hours. However, due to the zero cells in this category, it was treated as a continuous variable in multivariable analysis. The third delay, which was the delay in receiving care, was categorized as <1 hour and >1 hour.[21] Respondents were deemed to have good knowledge of pregnancy danger signs if they answered correctly on more than half of the knowledge questions; otherwise, they were deemed to have poor knowledge. The knowledge questions covered symptoms of pregnancy danger signs such as fever, swollen legs, blurred vision, intense headache, offensive vaginal discharge, bleeding, and blurring of the vision. When respondents met at least one requirement of the birth preparedness plan during their current pregnancy, they were deemed to be birth-prepared; in the absence of such requirements, they were deemed to be unprepared for childbirth.

Sample size and sampling procedure

The sample size was estimated for unmatched case-control studies using Epi-Info version 7.2.2.6 software with the following assumptions: 80% power, 95% confidence interval (CI), and a 3:1 control-to-case ratio. Exposure status of controls and odds ratio (OR) for significant determinant factors were taken from a facility-based case-control study conducted in selected public hospitals in the Tigray region, northern Ethiopia, taking age at first pregnancy of <16 years compared to ≥20 years as one of the main exposure variable for MNM that provide the maximum sample size.[14] The percent of controls exposed to the stated variable was 18.5% and OR was 2.5. Accordingly, a minimum sample size of 279 women (70 cases and 209 controls) was calculated.

The study covered all of the public hospitals in the Hadiya zone. To find the average monthly obstetric client flow rate of the respective hospitals for delivery, the obstetric case management report for the last 6 months' total deliveries from each public hospital was consulted. Each hospital that was chosen received a proportionate share of the sample size. All MNM cases during the study period were consecutively included, and for each near-miss case, three controls were selected using systematic random sampling, and accordingly, the interval of every three women was taken (k=907/279=3). Patient cards, admission logbooks, and operating room logbooks were used to identify cases.

Data collection procedure and instrument

A structured interviewer-administered questionnaire and MNM checklist were used to gather data. These tools were developed after a thorough review of the literature and were based on the WHO MNM tool, which was slightly modified for use in sub-Saharan Africa.[9] A version of the questionnaire prepared in the local language (Amharic) was used to collect the data. To collect data, methods such as face-to-face interviews and client record reviews were used. Clients' record review was used to identify a near-miss diagnosis for case selection and attendance of the current delivery; otherwise, other variables were assessed directly by interviewing the cases and controls by well-trained midwives. The interview was held in a private area and near discharge from the hospital. The overall data collection process was supervised by a trained general practitioner working in the respective hospitals. Each hospital's obstetric intensive care unit and gynecology ward were visited to gather data.

Data quality management

The questions prepared in English were translated into Amharic and back-translated to English by different expert translators to check for consistency. A pre-test was carried out at Worabe Comprehensive Hospital on 5% of the sample size for one week, and any inconsistencies in the tools were corrected. Data collectors were trained for 2 days on the objectives of the study, data collection techniques, and tools. The principal investigator and trained supervisors also checked the consistency and completeness of the data every day.

Data processing and analysis

After being reviewed for completeness, each questionnaire was coded, entered into Epi-data Version 4.4 (EpiData, Denmark), and exported to SPSS for Windows Version 24 for analysis (IBM, Armonk, NY, USA). After the data was cleaned, the analysis was performed. To describe the study population in terms of socio-demographic factors and other pertinent variables for cases and controls, frequencies, proportions, and measures of variation were employed. A binary logistic regression model was built. The relationship between each independent variable and the outcome variable was examined using bivariate logistic regression; variables for the final multivariable logistic regression model were selected based on a p-value of less than 0.20 to include potentially important variables in the model and to reduce the risk of overfitting the model. The Hosmer and Lemeshow goodness of fit test (x^2=1.86, p=0.868) was used to assess the model's fitness. OR and 95% CI were used to evaluate statistical significance, which was declared at a p-value of less than 0.05. The guidelines for STROBE case-control reporting were followed.

Results

Socio-demographic characteristics

After eligibility was verified, 279 participants (70 cases and 209 controls) were included in the study. The study participants had a mean age of 27.7 [5.4 standard deviation (SD)] years for cases and 26.9 (5.1 SD) years for controls. At that moment, married cases were 92.9%, whereas controls were 94.3%. As

their occupation, housewives made up more than three-quarters of the cases (77.1%) and half of the controls (58.9%). The proportion of cases from rural areas (72.9% *versus* 32.5%) is twice that of controls. Similarly, the proportion of cases with no formal education is twice that of controls (40.0% *versus* 19.6%). For the cases, the family's median monthly income was 2362.5 birrs [interquartile range (IQR) 1362.5 to 3000.0] while for the controls, it was 3000.0 birrs (IQR 1,500.0 to 5000.0) (Table 2).

Obstetric and reproductive health history of the women

Contraception was used by a larger percentage of controls (57.0%) than cases (38.0%). Among cases, the median number of pregnancies was 3.5 (IQR 1.0 to 6.0), whereas among controls, it was 2.0 (IQR 1.0 to 3.5). The grand multigravida (>5 pregnancies) percentage is twice as high in cases as it is in controls (38.6% *versus* 16.2%). The birth interval was measured in years, with the mean for cases being 1.7 (0.7 SD) and the mean for controls being 2.6 (1.1 SD). In cases, the percentage of birth intervals less than 2 years nearly quadruples compared to controls (43.8% *versus* 11.7%). Eight cases and five controls gave their current birth at home (Table 3).

Just 3.3% of controls and 24% of cases have multiple pregnancies at any point in their lives. 7.7% of controls had a stillbirth in their lifetime, compared to 26.0% of cases. Abortion has been experienced in 37.1% of cases and 12.0% of controls. Concerning complications from prior pregnancies, the most frequent types among cases were *postpartum* hemorrhage (37.9%) and hypertension (37.9%), while the most common types among controls were *antepartum* hemorrhage (23.1%) and premature rupture of membranes (26.9%). The percentage of cases that used maternity waiting homes during their current pregnancy was only 12.9%, compared to 21.5% of controls.

In their current pregnancy, 73% of cases and 94.3% of controls received ANC.45.7% of controls and 43.1% of cases among those who received ANC were booked at health centers. In terms of ANC contact frequency, 39.6% of controls and 47.1% of cases have had fewer than four ANC contacts. Three times as many cases (41.2%) as controls (13.2%) had an antenatal admission during their current pregnancy. In cases, hypertension accounted for 33.3% of prenatal admissions, while hyperemesis gravidarum was the primary cause of antenatal admissions in 70.4% of controls. At their booking visit, 12.7% of controls and 22% of cases were not informed about the danger signs of pregnancy (Table 3).

The previous medical condition of the women

One-sixth of controls (17.7%) and more than four out of ten cases (42.9%) have ever had a medical condition in the past. Hypertension was the most prevalent type of previous medical condition in both cases (27.1%) and controls (7.2%), and it was followed by renal disease, anemia, diabetes mellitus, and asthma.

Three delays and referral status

Referrals from medical facilities outside the study setting accounted for one-fifth (21.5%) of the controls and three-fourths (74.3%) of the cases. Among cases, the median delay in seeking medical attention was 6.0 (IQR 3.0 to 10.0) hours, while among controls, it was 2.5 (IQR 1.0 to 6.0) hours. In comparison to controls, cases experienced a mean second delay of 2.2 hours (1.4 SD), while controls experienced 1.6 hours (1.4 SD). The third delay had a median duration of 48 minutes for both cases and controls, with an IQR of 42-60 for cases and 24-60 for controls (Table 3).

Determinants of maternal near-miss

In the multi-variable binary logistic regression analysis, the variables found to have an association with MNM in the final model were rural residence [adjusted OR (AOR)=3.16; 95% CI: 1.62, 6.16)], no birth preparedness (AOR=3.50; 95% CI: 1.66, 7.41), previous C/S (AOR=3.68; 95% CI: 1.63, 8.31), previous

history of hypertension (AOR=3.69; 95% CI: 1.52, 8.96), and poor knowledge of pregnancy danger signs (AOR=3.15; 95% CI: 1.32, 7.52) (Table 4).

Discussion

According to this study, women who live in rural areas are three times more likely than women who live in urban areas to experience MNM. The results of this study were similar to those of a study carried out in public hospitals in Addis Ababa, Ethiopia, where it was discovered that rural residence was a determinant factor of MNM.[17] In a study done in Southwest Nigeria and India, living in a rural area was also a significant determinant factor of MNM.[22,23] It could be because of the hospitals' locations in urban and semi-urban areas, the ease of access to transportation, and the state of the roads, as well as the availability of information and better medical care. These could suggest that, even with government initiatives to provide basic health services to rural women, these women may still encounter more obstacles than urban women in getting access to healthcare. Additionally, a higher percentage of rural women in this study chose to give birth at home, did not receive prenatal care during their current pregnancy, were referred by other medical facilities, and required a longer commute to get to hospitals. Due to their later arrival at hospitals than urban women, all of these may exacerbate their condition and raise their risk of morbidity. Therefore, increasing road and transit infrastructure, further decentralizing maternity care, and prioritizing public health initiatives for rural women could all help lower the rate of MNM.

Similarly, the odds of experiencing MNM were more than three times higher for women without birth preparedness than for those who did. A meta-analysis and systematic review of randomized trials of birth preparedness and complication readiness (BPCR) interventions in populations of pregnant women living in developing countries provided support for this finding, demonstrating that exposure to BPCR interventions was associated with a statistically significant reduction in the risk of maternal mortality by 53%.[24] This suggests that although birth preparedness is a significant factor for MNM, it was not adequately addressed in ANC services. For instance, in the present study, nearly three-fourths of cases and more than nine in ten controls received ANC in their current pregnancy, and similarly, last year's zonal ANC4 coverage was 93%. This suggests that although ANC services were provided, their effectiveness was in doubt.

In addition, women who ever gave birth by C/S had nearly four times higher odds of developing MNM compared to women with no history of C/S. According to previous research, the results were similar in the Gurage zone, in southern Ethiopia, and public hospitals in northern Ethiopia.[6,14] A comparable conclusion was also reported in a study conducted in Erbil City, Iraq.[25] A woman who gives birth vaginally after a C/S runs the risk of experiencing uterine rupture during her subsequent deliveries. This is because the scar from the previous C/S may cause uterine rupture, which could result in MNM. The results imply that limits on C/S preferences ought to be implemented and that potential risks associated with C/S ought to be considered when evaluating clinical indications for the procedure.

The study also showed that women with a previous history of hypertension had almost four times higher odds of developing MNM compared to women with no history of hypertension. Findings from other studies carried out in Addis Ababa, Nigeria, and Brazil revealed that a history of hypertension was a risk factor for MNM.[17,26,27] The current pregnancy may be at risk for hypertension given the prior history, which could also exacerbate the consequences of superimposed pre-eclampsia in MNM. Perhaps promoting a culture of chronic illness screening, especially for hypertension, and providing targeted prenatal care would significantly reduce the incidence of MNM.

Furthermore, compared to women who had good knowledge of pregnancy danger signs, the odds of MNM were three times higher for those who had poor knowledge. This finding was supported by a study conducted in Ethiopia that concluded that timely recognition of these danger signs is central to the

survival of women.[28] The identification of these danger signs and their relation to complications during pregnancy would increase the capacity of women, their partners, and their families to seek timely health care.[29] Empowering women, men, families, and communities to identify pregnancy-related risks is one of Ethiopia's two national reproductive strategies.[30] While the national strategy places a lot of emphasis on increasing awareness of obstetric danger signs, the updated strategy made no such mentions.[28] The current study's findings also showed that a lack of awareness persisted in the study area, as 22% of cases and 12.7% of controls did not receive information about pregnancy danger signs during their booking visit. Therefore, the goal of ANC should be to provide pregnant women with information in addition to diagnosing symptoms and delaying the emergence of potentially fatal complications. Concerned parties should also use various mass media outlets to spread knowledge about obstetric danger signs.

The fact that the current study included referrals in addition to district hospitals raises questions about its representativeness. Nevertheless, there were certain limitations to the study. This study did not include any private health facilities, so it may not accurately reflect MNM cases at private facilities. Furthermore, the study participants were monitored exclusively until their hospital discharge. This means that a control *postpartum* woman, who should be monitored for 42 days *postpartum*, may experience a near-miss following her discharge and thus be excluded from the study. The present study was also limited by recall and social desirability biases, as the data was collected retrospectively and patients might have felt guilty about certain information.

Conclusions

Rural residence, reproductive and obstetric factors such as no birth preparedness, C/S, poor knowledge of pregnancy danger signs, and a previous history of hypertension were significant determinant factors of MNM. In light of the attainment of the sustainable development goal of reducing the maternal mortality ratio below 70 per 100,000 live births by 2030, it is imperative that findings from this study be used to inform interventions. So, we need evidence-based clinical and public health intervention programs, particularly targeting determinant factors for the reduction of maternal morbidity and mortality, while rural women need extra vigilance.

References

1. World Health Organization. Health in 2015: from MDGs to SDGs. Available on: https://www.who.int/data/gho/publications/mdgs-sdgs.
2. Almerie Y, Almerie MQ, Matar HE, et al. Obstetric near-miss and maternal mortality in a maternity university hospital, Damascus, Syria: a retrospective study. BMC Pregnancy Childbirth 2010;10:65.
3. Say L, Pattinson RC, Gülmezoglu AM. WHO systematic review of maternal morbidity and mortality: the prevalence of severe acute maternal morbidity (near miss). Reprod Health 2004;1:3.
4. Liyew EF, Yalew AW, Afework MF, Essén B. Incidence and causes of maternal near-miss in selected hospitals of Addis Ababa, Ethiopia. PLoS One 2017;12:e0179013.
5. Lewis G. Beyond the numbers: reviewing maternal deaths and complications to make pregnancy safer. Br Med Bull 2003;67:27-37.
6. Kasahun AW, Wako WG. Predictors of maternal near miss among women admitted in Gurage zone hospitals, South Ethiopia, 2017, a case-control study. BMC Pregnancy Childbirth 2018;18:260.
7. World Health Organization. Evaluating the quality of care for severe pregnancy complications. 2011. Available from: https://iris.who.int/bitstream/handle/10665/44692/9789241502221_eng.pdf?sequence=1.

8. Witteveen T, Bezstarosti H, de Koning I, et al. Validating the WHO maternal near miss tool: comparing high- and low-resource settings. BMC Pregnancy Childbirth 2017;17:194.
9. Tura AK, Stekelenburg J, Scherjon SA, et al. Adaptation of the WHO maternal near miss tool for use in sub–Saharan Africa: an International Delphi study. BMC Pregnancy Childbirth 2017;17:445.
10. Kaye DK, Kakaire O, Osinde MO. Systematic review of the magnitude and case fatality ratio for severe maternal morbidity in sub-Saharan Africa between 1995 and 2010. BMC Pregnancy Childbirth 2011;11:65.
11. Gebrehiwot Y, Tewolde BT. Improving maternity care in Ethiopia through facility-based review of maternal deaths and near misses. Int J Gynecol and Obstet 2014;127:S29-34.
12. Lindtjørn B, Mitiku D, Zidda Z, Yaya Y. Reducing maternal deaths in Ethiopia: results of an intervention programme in southwest Ethiopia. PLoS One 2017;12:e0169304.
13. Tuncalp O, Hindin MJ, Souza JP, et al. The prevalence of maternal near miss: a systematic review. BJOG 2012;119:653-61.
14. Mekango DE, Alemayehu M, Gebregergs GB, et al. Determinants of maternal near miss among women in public hospital maternity wards in northern Ethiopia: a facility-based case-control study. PLoS One 2017;12:e0183886.
15. Gedefaw M, Gebrehana H, Gizachew A, Taddess F. Assessment of maternal near miss at Debre Markos referral hospital, northwest Ethiopia: five years experience. Open J Epidemiol 2014;4:199-207.
16. Dile M, Seyum T. Proportion of maternal near misses and associated factors in referral hospitals of Amhara regional state, northwest Ethiopia: institution-based cross-sectional study. Gynecol Obstet 2015;5:308.
17. Liyew EF, Yalew AW, Afework MF, Essén B. Distant and proximate factors associated with maternal near-miss: a nested case-control study in selected public hospitals of Addis Ababa, Ethiopia. BMC Womens Health 2018;18:28.
18. United Nations. Transforming our world: the 2030 agenda for sustainable development. 2015. Available from: https://sdgs.un.org/2030agenda.
19. Ethiopian Public Health Institute FMoH. Ethiopia Mini Demographic and Health Survey 2019.
20. World Bank, Ministry of Health Ethiopia. Ethiopia. A Country status report on health and poverty. 2005.
21. Assarag B, Dujardin B, Delamou A, et al. Determinants of maternal near-miss in Morocco: too late, too far, too sloppy? PloS One 2015;10:e0116675.
22. Bakshi RK, Roy D, Aggarwal P, et al. Demographic determinants of maternal "near-miss" cases in rural Uttarakhand. Natl J Community Med 2014;5:329-32.
23. Aduloju OP, Aduloju T, Ipinnimo OM. Profile of maternal near miss and determinant factors in a teaching hospital, southwestern Nigeria. Int J Obstet Gynaecol Res 2018;5:598-617.
24. Soubeiga D, Gauvin L, Hatem MA, Johri M. Birth Preparedness and complication readiness (BPCR) interventions to reduce maternal and neonatal mortality in developing countries: systematic review and meta-analysis. BMC Pregnancy Childbirth 2014;14:129.
25. Akrawi VS, Al-Hadithi TS, Al-Tawil NG. Major determinants of maternal near miss and mortality at the maternity teaching hospital, Erbil city, Iraq. Oman Med J 2017;32:386-95.
26. Adeoye IA, Onayade AA, Fatusi AO. Incidence, determinants and perinatal outcomes of near miss maternal morbidity in Ile-Ife Nigeria: a prospective case-control study. BMC Pregnancy Childbirth 2013;13:93.
27. De Moraes APP, Barreto SM, Passos VMA, et al. Severe maternal morbidity: a case-control study in Maranhao, Brazil. Reprod Health 2013;10:11.

28. Hailu M, Gebremariam A, Alemsged F. Knowledge about obstetric danger signs among pregnant women in AlettaWondo district, Sidama zone, Southern Ethiopia. Ethiop J Health Sci 2010;20:25-32.
29. World Health Organization. Standards for maternal and neonatal care. https://iris.who.int/bitstream/handle/10665/69735/a91272.pdf?sequence=1.
30. Federal Democratic Republic of Ethiopia - Ministry of Health. National reproductive strategy 2006-2015. 2006. Available from: https://www.exemplars.health/-/media/files/n-mmr/ethiopia-national-reproductive-health-strategy-2006-2015.pdf.

Table 1. Adapted sub-Saharan Africa maternal near-miss tool used in this study (Tura *et al.*, 2017,[9] https://creativecommons.org/licenses/by/4.0/).

Category related to WHO maternal near-miss criteria	Adapted sub-Saharan Africa maternal near-miss criteria	Definitions
Clinical criteria	Acute cyanosis	Acute cyanosis is the blue or purple coloration of the skin or mucous membranes due to low oxygen saturation.
	Gasping	Gasping is a terminal respiratory pattern and the breath is convulsively and audibly caught.
	Respiratory rate >40 or <6/min	
	Shock	Shock is persistent severe hypotension, defined as a systolic BP <90 mmHg for ≥60 min with a pulse rate of at least 120 despite aggressive fluid replacement (> 2 L).
	Oliguria non responsive to fluids or diuretics	Oliguria is urinary output <30 ml/h for 4 h or <400 mL/24 hours.
	Failure to form clots	Failure to form clots can be assessed by the bedside clotting test or absence of clotting from the IV site after 7-10 minutes.
	Loss of consciousness lasting more than 12 hours	Loss of consciousness lasting >12 h is a profound alteration of mental state that involves complete or near-complete lack of responsiveness to external stimuli. It is defined as a Glasgow Coma Scale <10 (moderate or severe coma).
	Cardiac arrest	
	Stroke	A stroke is a neurological deficit of cerebrovascular cause that persists beyond 24 hours or is interrupted by death within 24 hours.
	Uncontrollable fit/ total paralysis	Uncontrolled fits/total paralysis is refractory, persistent convulsions, or status epilepticus.
	Jaundice in the presence of preeclampsia	Pre-eclampsia is defined as the presence of hypertension associated with proteinuria. Hypertension is defined as a BP of at least 140/90 mmHg on at least two occasions and at least 4-6 h apart after the 20th week of gestation in women known to be normotensive beforehand. Proteinuria is defined as the excretion of 300 mg or more of protein every 24 hours. If 24-hour urine samples are not available, proteinuria is defined as a protein concentration of 300 mg/l or more (≥1 on dipstick) in at least two random urine samples taken at least 4-6 h apart.

Other additional adapted sub-Saharan Africa maternal near-miss clinical criteria other than WHO maternal near-miss criteria	Eclampsia	Eclampsia is diastolic BP≥90 mmHg or proteinuria +3 and convulsion or coma.
	Uterine rupture	Uterine rupture is a complete rupture of the uterus during labor and/or confirmed later by laparotomy.
	Sepsis or severe systemic infection	Sepsis or severe systemic infection is defined as a clinical sign of infection and 3 of the following: temp >38°C or <36°C, respiration rate >20/min, pulse rate >90/min, WBC>12,000.
	Pulmonary edema	Pulmonary edema is an accumulation of fluids in the air spaces and parenchyma of the lungs.
	Severe abortion complications	Severe abortion complications are defined as septic incomplete abortion or complicated gestational trophoblastic disease with anemia.
	Severe malaria	Severe malaria is defined as major signs of organ dysfunction and/or high-level parasitemia or cerebral malaria
	Severe pre-eclampsia with ICU admission	Severe pre-eclampsia: Persistent systolic blood pressure of 160 mmHg or more or a diastolic blood pressure of 110 mmHg; and either proteinuria of 5 g or more in 24 hours; or oliguria of <400 mL in 24 hours; or HELLP syndrome.
	Severe *postpartum* hemorrhage	if a woman experience genital bleeding after delivery with at least hypotension or result in blood transfusion.
Laboratory-based criteria	Oxygen saturation <90% for >60 min	
	Creatinine≥300µmol/l or ≥3.5 mg/dL	
	Acute thrombocytopenia (<50,000 platelets/ml)	
	Loss of consciousness and ketoacids in urine	
Management based criteria	Hysterectomy following infection or hemorrhage	
	Transfusion of≥2 units of red blood cells	
	Intubation and ventilation for ≥60 min not related to anesthesia	
	Cardio-pulmonary resuscitation	
	Laparotomy other than cesarean section	

WHO, World Health Organization; BP, blood pressure; WBC, white blood cell; ICU, intensive care unit; HELLP, hemolysis, low liver enzymes, and low platelet count. This adapted tool[9] was also used in another study for maternal near-miss cases detection as part of the research project with different objective and published elsewhere.

Table 2. Socio-demographic characteristics of women admitted to public hospitals in the Hadiya zone of central Ethiopia, 2019 (n=279).

Variable	Category	Maternal near-miss status		Total (n=279) Frequency (%)
		Yes (n=70) Frequency (%)	No (n=209) Frequency (%)	
Age of participants	18-29 years	43 (61.4)	146 (69.9)	189 (67.7)
	30-41 years	27 (38.6)	63 (30.1)	90 (32.3)
Permanent residence	Rural	51 (72.9)	68 (32.5)	119 (42.7)
	Urban	19 (27.1)	141 (67.5)	160 (57.3)
Participant occupation	Housewife	54 (77.1)	123 (58.9)	177 (63.4)
	Civil Servant	11 (15.7)	46 (22.0)	57 (20.4)
	Merchant	4 (5.7)	26 (12.4)	30 (10.8)
	Other (maid, student, daily laborer)	1 (1.4)	14 (6.7)	15 (5.4)

Participants' level of education	No formal education	28 (40.0)	41 (19.6)	69 (24.7)
	Primary school (1-8)	25 (35.7)	81 (38.8)	106 (38.0)
	Secondary school (9-12)	5 (7.1)	33 (15.8)	38 (13.6)
	Tertiary or higher (12+)	12 (17.1)	54 (25.8)	66 (23.7)
Monthly income	≤2500 birr	51 (72.9)	96 (5.9)	147 (52.7)
	>2500 birr	19 (27.1)	113 (54.1)	132 (47.3)

Table 3. Women's reproductive health and obstetric history, and the three delays among women admitted to public hospitals in the Hadiya zone of central Ethiopia, 2019 (n=279).

Variable	Category	Maternal near-miss status		Total (n=279) Frequency (%)
		Yes (n=70) Frequency (%)	No (n=209) Frequency (%)	
Female genital mutilation	Yes	55 (78.6)	123 (58.9)	185 (66.3)
	No	15 (21.4)	86 (41.1)	94 (33.7)
Birth preparedness for current delivery	Yes	40 (57.1)	187 (89.5)	227 (81.4)
	No	30 (42.9)	22 (10.5)	52 (18.6)
Gravidity	Primigravida	22 (31.4)	81 (38.8)	103 (36.9)
	Multigravida	21 (30.0)	94 (45.0)	115 (41.2)
	Grand multigravida	27 (38.6)	34 (16.2)	61 (21.9)
Birth interval n=176 (48:128)	<2 years	21 (43.8)	15 (11.7)	36 (20.5)
	≥2 years	27 (56.2)	113 (88.3)	140 (79.5)
Ever gave birth by cesarean section	Yes	23 (32.9)	19 (9.1)	42 (15.1)
	No	47 (67.1)	190 (90.9)	237 (84.9)
Previous pregnancy complications	Yes	29 (41.4)	26 (12.4)	55 (19.7)
	No	41 (58.6)	183 (87.6)	224 (80.3)
Receive ANC in the current pregnancy	Yes	51 (72.9)	197 (94.3)	248 (88.9)
	No	19 (27.1)	12 (5.7)	31 (11.1)
Antenatal admissions in the current pregnancy n = 248 (51:197)	Yes	21 (41.2)	26 (13.2)	47 (19.0)
	No	30 (58.8)	171 (86.8)	201 (81.0)
Knowledge of pregnancy danger signs	Poor knowledge	62 (88.6)	126 (60.3)	188 (67.4)
	Good knowledge	8 (11.4)	83 (39.7)	91 (32.6)
First delay	Delayed <12 hours	54 (77.1)	148 (70.8)	202 (72.4)
	Delayed ≥12 hours	16 (22.9)	61 (29.2)	77 (27.6)
Second delay	Travelled ≤2 hours	51 (72.9)	183 (87.6)	234 (83.9)
	Travelled >2 hours	19 (27.1)	26 (12.4)	45 (16.1)
Third delay	Delayed <1 hour	47 (67.1)	112 (53.6)	237 (84.9)
	Delayed ≥1 hour	23 (32.9)	97 (46.4)	42 (15.1)

ANC, antenatal care.

Table 4. Determinant factors of maternal near-miss among women admitted to public hospitals in the Hadiya zone of central Ethiopia, 2019 (n=279; 70:209 cases to controls ratio).

Variable	Category	Maternal near-miss status		COR (95% CI)	AOR (95% CI)
		Yes No (%)	No No (%)		
Permanent residence	Rural	51 (72.9)	68 (32.5)	5.57 (3.05, 10.15)	3.16 (1.62, 6.16)**
	Urban	19 (27.1)	141 (67.5)	1.00	1.00
Female Genital Mutilation	Yes	55 (78.6)	123 (58.9)	2.56 (1.36, 4.83)	1.29 (0.58, 2.86)
	No	15 (21.4)	86 (41.1)	1.00	1.00
Receive ANC in a current pregnancy	Yes	51 (72.9)	197 (94.3)	0.16 (0.08, 0.36)	1.04 (0.32, 3.39)
	No	19 (27.1)	12 (5.7)	1.00	1.00
Ever gave stillbirth	Yes	18 (25.7)	16 (7.7)	4.18 (1.99, 8.75)	1.53 (0.55, 4.27)
	No	52 (74.3)	193 (92.3)	1.00	1.00
Ever experience abortion	Yes	26 (37.1)	25 (12.0)	4.35 (2.29, 8.25)	1.81 (0.82, 3.99)
	No	44 (62.9)	184 (88.0)	1.00	1.00
Ever gave birth by cesarean section	Yes	23 (32.9)	19 (9.1)	4.89 (2.46, 9.72)	3.68 (1.63, 8.31)*
	No	47 (67.1)	190 (90.9)	1.00	1.00
Birth preparedness for current delivery	Yes	40 (57.1)	187 (89.5)	1.00	1.00
	No	30 (42.9)	22 (10.5)	6.37 (3.34, 12.18)	3.50 (1.66, 7.41)**
Knowledge of pregnancy danger signs	Poor	62 (88.6)	126 (60.3)	5.11 (2.33, 11.21)	3.15 (1.32, 7.52)*
	Good	8 (11.4)	83 (39.7)	1.00	1.00
Previous history of hypertension	Yes	19 (27.1)	15 (7.2)	4.82 (2.29, 10.14)	3.69 (1.52, 8.96)*
	No	51 (72.9)	194 (92.8)	1.00	1.00
Second delay	Traveled ≤2 hours	51 (72.9)	183 (87.6)	0.38 (0.20, 0.74)	0.92 (0.37, 2.29)
	Traveled >2 hours	19 (27.1)	26 (12.4)	1.00	1.00

COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval; ANC, antenatal care; *statistically significant variables at p=0.004; **significant at p≤0.001.

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