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Determinants of maternal near miss among women in public hospital maternity wards in gambella region health facility, gambella, Southwest of Ethiopia: A facility based unmatched case: control study, 2019

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Abstract
Background: In Ethiopia, 20,000 women die each year from complications during pregnancy, childbirth and the post-partum period. For every woman who dies of pregnancy complications, about 20 more experience injury, infection, disease, or disability. In Ethiopia, few studies have been performed on MNM, and little is known regarding determinant factors. This study aims to identify determinants of MNM among women in Gambella Region, Ethiopia.
Methods: Unmatched case-control study in hospitals in Gambella Region, southwest of Ethiopia, from July 01 - August 30, 2019. The sample included 103 cases and 205 controls recruited from women seeking obstetric care at six public hospitals. Clients having a life-threatening obstetric complication including hemorrhage, hypertensive diseases of pregnancy, dystocia, infections, and anemia or clinical signs of severe anemia in women without hemorrhage were taken as cases and those with normal obstetric outcomes were considered as controls. Cases were selected based on proportional to size allocation while systematic sampling was employed for controls. Data on socio-economic and demographic factors, reproductive history and nutrition related factors were collected using a structured questionnaire. Blood sample were collected to analyze biochemical indicators. Data was coded and entered into Epi-info version 3.5.4 and exported to SPSS version 20 for further cleaning and analysis. Multivariable logistic regression analysis was employed to assess the relative effect of various explanatory variables on the outcome variables. Variables with P-value less than 0.05 at 95 % confidence interval were considered as statistically significance.
Results: The largest share of cases and controls were between the ages of 20–29 years, accounting for 39(37.9%) of cases and 65(31.7%) of controls. Ninety-two (90.2%) of cases and 185(89.3%) of controls were married. About two-thirds of controls and 47(45.6%) of cases had gestational age between 37-41 weeks. History of chronic medical conditions was reported in 57(55.3%) of cases and 68(33.2%) of controls. Women with no formal education [AOR=3.2;95%CI:1.24, 8.12], being less than 16 years old at first pregnancy [AOR=2.5; 95%CI:1.12,5.63],induced labor[AOR=3; 95%CI:1.44, 6.17],history of C-section [AOR=4.6; 95%CI: 1.98, 7.61] and chronic medical disorder[AOR=3.5;95%CI:1.78, 6.93], and women who traveled more than 60 minutes before reaching their final place of care[AOR=2.8;95% CI: 1.19,6.35] all had higher odds of experiencing MNM.
Conclusions: The Government of Ethiopia should continue efforts to address lack of road and health facility access and education. Work should also be continued to educate women and providers about common predictors of MNM like history of C-section and chronic illness as well as teenage pregnancy at the facility, community, family and individual levels. Targeted follow-up to women with history of chronic disease and C-section could also be a practical way to reduce MNM.

Keywords: maternal near miss, mnm, severe obstetric hemorrhage, hypertensive disorder, c section, Gambella, Ethiopia

Introduction
As the Millennium Development Goals (MDG) era ends, maternal mortality has declined 45%, an impressive achievement, but short of the target of 75% reduction in maternal mortality. Today, approximately 830 women die every day from pregnancy or childbirth complications. Almost all (99%) of these deaths occur in low-resource settings and most could be prevented [30]. Among developing regions, Sub-Saharan Africa (SSA) has the highest maternal mortality ratio (MMR) at 640 per 100,000 live births [30, 2].
MNM is also increasingly identified as a means of examining the quality of obstetric care improving clinical practice, reinforce lessons learned. Improved quality of obstetric care can help address MNM and maternal deaths and also improve maternal health [2, 4, 5].
In Ethiopia, about 20,000 women die each year from complications during pregnancy, childbirth and the post-partum period [6]. A study at Ayder Referral Hospital in Tigray, Ethiopia showed that there were 204 severe acute maternal morbidities (SAMM) and 9 direct maternal deaths, equating to 22.7 SAMMs for every maternal death. The study also showed 101 SAMMs per 1,000 deliveries and an MMR of 427 per 100,000 live births [7].
To devise strategies to curb maternal mortality in Ethiopia, knowing the determinants of maternal mortality and morbidity is essential [8]. However, reliable information is not available [9, 10, 11]. Therefore, this study can contribute to the evidence-baserequired to design interventions to minimize pregnancy-related complications and maternal

death.

Methods and Materials

Study area, period and Study design

The study was conducted at Gambella hospital which is found in Gambella region. The region has an elevation ranging from 400 to 600 meters above the sea level and largely hot climatic zone. The capital city of the region is Gambella town which is located at 768 km from the capital city of Ethiopia, Addis Ababa to Southwest direction. According to the Gambella people national regional state villagealation program sites the region has a total population of 422,002 [53]. ANC coverage of the town is 68%. Gambella Hospital provides surgical, medical, pediatric, gynecologic, and obstetric, ANC and ophthalmologic services to the community for over 51,696 inhabitants and displaced people from south Soudan. According to the Hospital monthly report, around 350 pregnant women have been enrolled to ANC. On average, 15-20 pregnant women visit ANC daily [54]. The study was conducted between July 01 - August 30, 2019. The study used a facility-based, unmatched case control design was employed at Gambella Hospital. Sample size was estimated using a single population proportion formula based on a study from Morocco that showed hypertensive disease contributing the majority of complications [12]. Based on the study, we hypothesized the proportion of chronic hypertension to be double in cases (63.9%) and controls (47%), 95% confidence level, and 80 % power of a test, 1:2 ratio for cases and controls. The total sample size was determined to 308, of which 103 were cases and 205 controls, and was determined using EPI Info [7].

In sampled hospitals, all clients who came seeking care at maternity wards with life-threatening obstetric complications were considered cases and clients who came seeking care from the maternity wards without life-threatening obstetric complications were considered as controls. Systematic sampling was employed for controls, while cases were sequentially recruited. We considered MNM as a condition meeting any of the five disease-specific criteria Proposed by Filippi [14]: severe obstetric hemorrhage leading to shock, emergency hysterectomy, and blood transfusion; hypertensive diseases of pregnancy, including eclampsia and severe preeclampsia; dystocia, including uterine rupture and impending rupture; infections, including hyper- or hypothermia or a clear source of infection and clinical signs of shock), and; anemia, including low hemoglobin level (<6 g/dl) or clinical signs of severe anemia in women without hemorrhage severe anemia (hemoglobin <6g/dl),

Any woman with at least one of the above complications was considereda case. Medical records were usedas a starting point to identify cases and controls. Data was collected using a structured questionnaire, administered in-person by nurse midwife interviewers. Socio-demographic characteristics, obstetric history, health-related factors, and knowledge of pregnancy-related danger signswere collected. Questionnaires were adapted froma WHO format and several studies taking into account the local context [9, 10, 11, 12, 15].

The questionnaire was prepared in English and translated to Tigrigna. It was checked for consistency by back-translation to English by two different individuals. Data was collected by 12 nurse midwives with experience in obstetric care. The data collection process was strictly supervised and data was checked for consistency and completeness. Incomplete and unclear questionnaires were returned to interviewers to be completed.

Data Analysis

Data was entered, cleaned and analyzed using SPSS 20. Data cleaning was done by running frequencies, cross-tabulation and sorting cases. Bar graphsand frequency (%) were used to represent results of categorical variable. Both bivariate and multivariate logistic regression analysis were used to determine the association of independent variables with the dependent variable. Variables with $p<0.25$ in bi-variate analysis were entered into a multivariate logistic regression model to adjust the effects of cofounders on the outcome variable. Odds ratios with 95% confidence interval was computed to identify the presence and strength of association, and statistical significance was declared if $p < 0.05$ was found. The final model was checked using the Hosmer–Lemeshow goodness of fit test. Co-founders, interaction and multi-collinearity were checked to minimize bias.

Ethics statement

The study protocol was approved by the Institutional Research Review Board of Mekelle University College of Health Sciences and Community Services Ethical Review Committee. Permission was obtained from all relevant authorities in the Tigray Regional Health Bureau and hospitals. Informed verbal consent was obtained from participants prior to enrollment in the study. Participation in the study was voluntary and participants were informed of the right to withdraw from the study. Data collection was conducted confidentially and data de-identified and de-linked and stored in a secure location.

Results

Socio-demographic characteristics of study participants

A total of 308 study participants were interviewed, with a response rate of 100%. The 20–29 age group accounted for37.9% (39) of cases and 31.7 %(65) of controls. Over three-fourths- 160(78%) - of controls and 59(57.3%) of cases were from urban areas. Forty-two (40.8%) of cases and 36(17.6%) of controls hadno formal education. About 24(23.3%) of cases and 84(41%) of controls had completed Secondary education. Close to 90% of cases and control swere married. Twenty-eight (27.2%) of cases were farmers and 77 (37.6%) of controls were housewives. About 35(34%) of cases and 63 (30.7%) of controls had average monthly income below 50 USD (Table 1).

Table 1: Socio-demographic characteristics of mothers admitted to public hospitals, Gambela, southwest Ethiopia, 2019. (N=308)

Variable	Category	Maternal Near Miss Status		
		Case n=103(%)	Control n=205(%)	Total N=308(%)
Age				
	<20	20(19.4)	49(23.9)	69(22.4)
	20-29	39(37.9)	65(31.7)	104(33.8)

	30-39	11(10.7)	36(17.6)	47(15.3)
	40-49	33(32)	55(26.8)	88(28.6)
Residence				
	Rural	44(42.7)	45(22)	89(28.9)
	Urban	59(57.3)	160(78)	219(71.1)
Maternal education				
	No formal education	42(40.8)	36(17.6)	78(25.3)
	Primary	3(2.9)	13(6.3)	16(5.2)
	Secondary	32(31.1)	74(36.1)	106(34.4)
	More than secondary	24(23.3)	84(41)	108(35.1)
Maternal occupation				
	Farmer	28(27.2)	32(15.6)	60(19.5)
	Housewife	25(24.3)	77(37.6)	102(33.1)
	Government employee	21(20.4)	68(33.2)	89(28.9)
	Merchant	11(10.7)	9(4.4)	20(6.5)
	Unemployed	9(8.7)	11(5.4)	20(6.5)
	Student	9(8.7)	8(3.9)	17(5.5)
Marital status				
	Single	2(1.9)	7(3.4)	9(2.9)
	Married	92(89.3)	185(90.2)	277(89.9)
	Divorced	9(8.7)	12(5.9)	21(6.8)
	Widowed	0	1(0.5)	1(0.3)
Husband education				
	Illiterate	35(38.5)	71(36.8)	106(37.3)
	Literate	56(61.5)	122(63.2)	178(62.7)
Husband occupation				
	Farmer	39(41.9)	38(19.8)	77(27)
	Government employee	26(28)	79(41.1)	105(36.8)
	Merchant	23(24.7)	`65(33.9)	88(30.9)
	Unemployed	5(5.4)	1(0.5)	6(2.1)
Monthly income				
	<50 USD	35(34)	63(30.7)	98(31.8)
	50 - 100 USD	33(32)	67(32.7)	100(32.5)
	>=150USD	35(34)	75(36.6)	110(35.7)

Obstetric history of study participants

Sixty-eight (33.2%) of controls and 40(38.8%) of cases had their first marriage before 18years of age. Forty-three (41.7%) of cases and 42(20.5%) of controls were gravida five and above.More than 112(54.6%) of controls and 45(43.7%) of cases had parity 1-2.The percentage of mothers at gestational age greater than 42 weeks was higher among cases 22(21.4%) than controls 28(13.7%). About two-third of controls and 47(45.6%) of cases were gestational age between 37-41 weeks. Roughly 80% of cases and controls had previously given birth at a facility.About 30(32.3%) of cases and 22(15.7%) of controls had birth interval of less than two years prior to the current delivery. Over three-fourths- 161(78.5%) - of controls and 54(52.4%) of cases had no history of abortion, while 29(28.2%) of cases and 35(17.1%) of controls had one abortion. Among mothers with history of abortion, 31(70.5%) of controls and 5(10.2%) of cases were aborted before 14 weeks, while 44(89.8%) of cases and 13(29.5%) of controls were aborted between 14-28 weeks of gestational age. The current pregnancy was intended by 129(62.9%) of controls and 63(61.8%) cases (Table 2).

Table 2: Obstetric characteristics of mothers admitted in public hospitals, Gambela, southwest Ethiopia, 2019. (N=308)

Variable	**Category**	**Maternal Near Miss Status**		
		Case n=103 (%)	Control n=205 (%)	Total N=308(%)
Age at 1st marriage				
	<=18 year	40(38.8)	68(33.2)	108(35.1)
	19-24 year	36(35)	91(44.4)	127(41.2)
	>=25 year	27(26.2)	46(22.4)	73(23.7)
Age at 1stpregnancy				
	<16 year	40(38.8)	38(18.5)	78(25.3)
	16-19 year	31(30.1)	68(33.2)	99(32.1)
	>=20 year	32(31.1)	99(48.3)	131(42.5)
Gravidity				
	1-2	40(38.8)	97(47.3)	137(44.5)
	3-4	20(19.4)	66(32.2)	86(27.9)
	>=5	43(41.7)	42(20.5)	85(27.6)
Parity				
	0	4(3.9)	1(0.5)	5(1.6)
	1-2	45(43.7)	112(54.6)	157(51)
	3-4	23(22.3)	57(27.8)	80(26)

GA at delivery				
	>=5	31(30.1)	35(17.1)	66(21.4)
	<37 week	34(33)	54(26.3)	88(28.6)
	37-41 week	47(45.6)	123(60)	170(55.2)
	>=42 week	22(21.4)	28(13.7)	50(16.2)
BI prior to current pregnancy				
	<2 year	30 (32.3)	22(15.7)	52(22.3)
	2 year	15(16.1)	73(52.1)	88(37.8)
	3 year	19(20.4)	30(21.4)	49(21)
	>=4 year	29(31.2)	15(10.7)	44(18.9)
Place of last birth				
	Home	21(22.6)	29(20.7)	50(21.5)
	Health facility	72(77.4)	111(79.3)	183(78.5)
Previous obstetric complication				
	Yes	64(68.8)	79(56.4)	143(61.4)
	No	29(31.2)	61(43.6)	90(38.6)
Labour inducement				
	Yes	46(44.7)	41(20)	87(28.2)
	No	57(55.3)	164(80)	221(71.8)
Neonatal condition at birth				
	Live birth	82(79.6)	173(84.4)	225(82.8)
	Still birth	21(20.4)	32(15.6)	53(17.2)
Birth weight				
	<1.5 kg	22(24.4)	52(26.4)	74(25.8)
	1.5-2.49 kg	30(33.3)	76(38.6)	106(36.9)
	2.5-4 kg	25(27.8)	53(26.9)	78(27.2)
	>4 kg	13(14.4)	16(8.1)	29(10.1)

*GA (Gestational Age), BI (Birth Interval)

Health related characteristics of the respondents

History of chronic medical disorder (hypertension, DM and CVD) was reported in 55.3 % (57) of cases and 68(33.2%) of controls. Forty-eight (46.6%) of cases and 40(19.5%) of controls had one previous C-section. Among those with history ofC-section, 20(40.8%) of them cases had two or more C-sections compared to 8(19%) ofcontrols.

Only 8(7.8%)of cases and 2(1%) of controls had no ANC follow-up. Nearly half, 38(48.1%) of cases and 10(5.2%) of controls started ANC from 24-28 weeks of gestation. Skilled birth attendants delivered 97(94.2%) of cases and 203(99%) of controls. Above half, 54(52.4%) of cases and more than three-fourths- 161 (78.5%) -of controls delivered at public hospitals. Fifty-one (49.5%) of cases and 67(32.7%) of controls were delivered by emergency C-section.

In terms of danger signs, 58(56.3%) of cases and 134(65.4%) of controls had good knowledge of obstetric danger signs. A higher proportion of cases (34%) waitedat home more than 36 hours before seeking obstetric care compared to 19.5% of controls. Nearly two-thirds 59(57.3%) of cases and 83(40.5%) of controls were delayed on the way to final place of care (Table 3).

Fifty-five (53.4%) of cases and 73(35.6%) of controls were referred. However, 132(64.4%) controls and 48(46.6%) of cases were not referred. Nearly half of cases- 29(46%) - and 17(26.2%) of controls were referred from health centers. Three times the number of women in the case group were self-referred compared to 2(3.1%) of controls (Table 3).

Table 3: Health-related characteristics of mothers admitted in public hospitals, Gambela, southwest Ethiopia, 2019. (N=308)

Variable	Category	Maternal Near Miss Status		
		Case n=103 (%)	Control n=205	Total N=308
Previous C-section				
	0	48(46.6)	146(71.2)	194(63)
	1	48(46.6)	40(19.5)	88(28.6)
	>=2	7(6.8)	19(9.3)	26(8.4)
ANC visit				
	0	8(7.8)	2(1)	10(3.2)
	1	11(10.7)	2(1)	13(4.2)
	2-3	54(52.4)	6(2.9)	60(19.5)
	>=4	30(29.1)	195(95.1)	225(73.1)
Gestational age at first ANC visit				
	<16 week	15(19)	174(89.7)	198(69.2)
	16-20 week	19(24.1)	10(5.2)	29(10.6)
	24-28 week	38(48.1)	10(5.2)	48(17.6)
	>=32	7(8.9)	0	7(2.6)
ANC received facility				
	Health post	26(27.4)	5(2.5)	31(10.4)
	Health center	46(48.4)	78(38.4)	124(41.6)
	Public hospital	22(23.2)	102(50.2)	124(41.6)
	Private clinic	1(1.1)	18(8.9)	19(6.4)

Place of current delivery				
	Home	2(1.9)	1(0.5)	3(1)
	Health post	1(1)	1(0.5)	2(0.6)
	Health center	46(44.7)	42(20.5)	88(28.6)
	Public hospital	54(52.4)	161(78.5)	215(69.8)
Birth attendants				
	Self	6(5.8)	2(1)	8(2.6)
	SBA	97(94.2)	203(99)	300(97.4)
Mode of current delivery				
	SVD	18(17.5)	67(32.7)	85(27.6)
	Emergency C/S	51(49.5)	64(31.2)	115(37.3)
	Instrumental	18(17.5)	41(20)	59(19.2)
	Elective C/S	16(15.5)	33(16.1)	49(15.9)
Type of current delivery				
	Singleton	103(100)	203(99)	306(99.4)
	>=twins	0	2(1)	2(0.6)
Delay home before decide to seek obstetric care				
	<24 hour	30(29.1)	99(48.3)	129(41.9)
	24-36 hour	38(36.9)	66(32.2)	104(33.8)
	>36 hour	35(34)	40(19.5)	75(24.4)
Delay before reaching the final place of care				
	<30 minute	19(18.4)	62(30.2)	81(27.3)
	30-60 minute	22(21.4)	60(29.3)	82(26.6)
	>60 minute	62(60.2)	83(40.5)	145(47.1)
Body mass index				
	<18.5	19(18.4)	41(20)	60(19.5)
	18.5-24.9	25(24.3)	104(50.7)	129(41.9)
	25-29.9	44(42.7)	48(23.4)	92(29.9)
	>=30	15(14.6)	12(5.9)	27(8.8)

*SVD (Spontaneous Vaginal Delivery), SBA (Skilled Birth Attendants), C/S (Caesarian Section), Instrumental (vacuum, forceps)

Over three-tenths (34.9%) of cases and 16.9% of controls were referred from health posts (Figure 3).

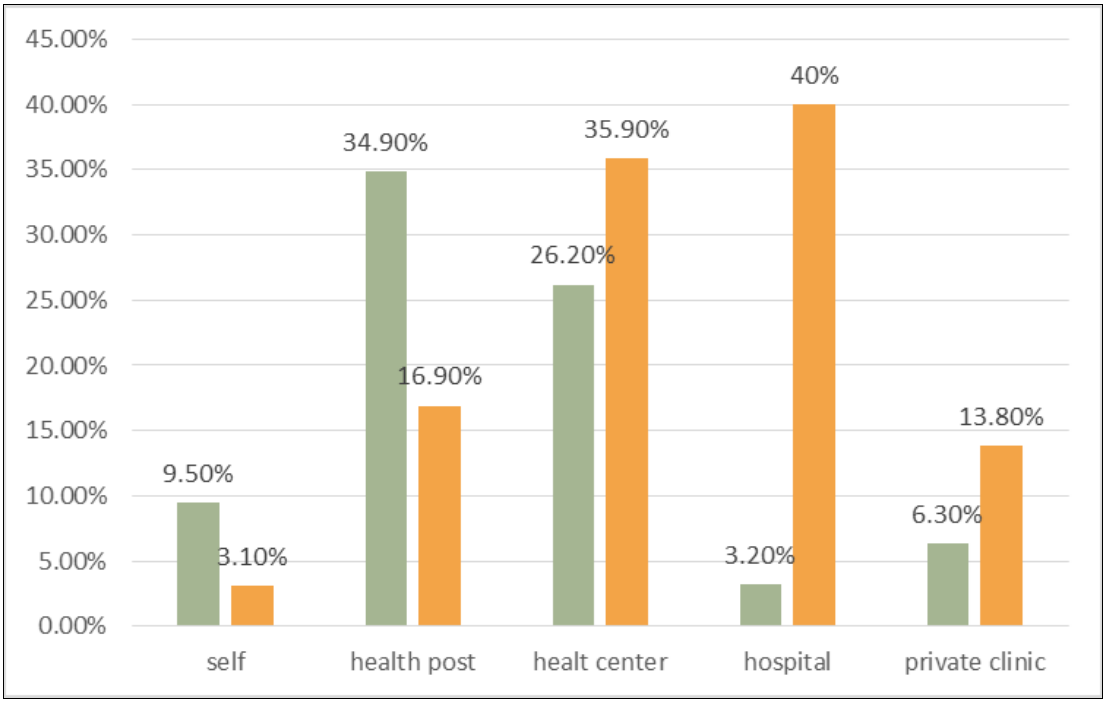

Fig 3: Source of referral among mothers admitted in public hospitals, Gambela, southwest Ethiopia, 2019. (N=308)

Only 20(19.4%) of cases and 47(22.9%) of controls were transported by ambulance.

Nearly 40% were transported using rented vehicles (Figure 4).

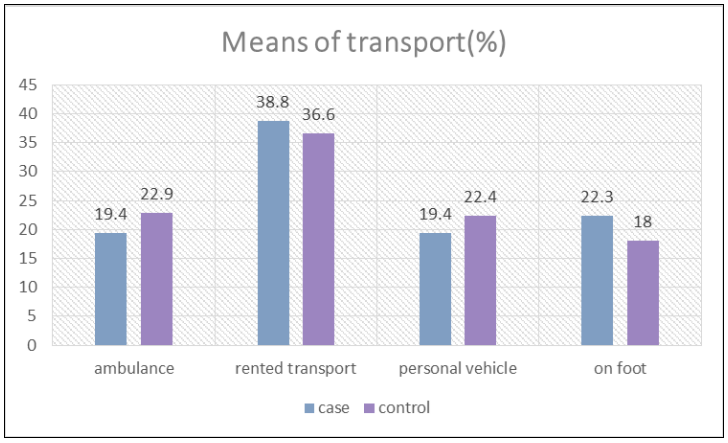

Fig 4: Means of transport used to reach referral hospital among mothers admitted in public hospitals, Gambela, southwest Ethiopia, 2019. 2016. (N=308)

Clinical characteristics of maternal near misses

Among cases, 11women had more than one life threatening obstetric complication. As shown in Table 4, disease specific diagnostic criteria of MNM were severe obstetric hemorrhage 46(44.7%), hypertensive disorders 40(38.8%), dystocia 18(17.5%), sepsis 10 (9.7%) and severe anemia 3(2.9%).Of cases with hemorrhagic disorders, 33(32%) were complicated by post-partum hemorrhage (Table 4).

Table 4: Clinical characteristics of maternal near misses

Maternal near miss events	MNM by condition (n=103)	
	n	%
Severe obstetric hemorrhage	46	44.7
Abruption placenta	8	7.8
Placenta previa	5	4.9
Retained placenta	14	13.6
Uterine atony	13	12.6
Uterine inversion	4	3.9
Disseminated Intra-vascular Coagulations	2	1.9
Hypertensive disorders	40	38.8
Severe pre-eclampsia	37	35.9
Eclampsia	3	2.9
Dystocia	18	17.5
Prolonged/obstructed labor with previous C/S	12	11.7
Uterine rupture	6	5.8
Infection	10	9.7
Sepsis	10	9.7
Severe anemia	3	2.9

*Near misses may have multiple complications.

Determinants of maternal near miss

Mothers who had no formal education had odds3.2 times higher of being a case than other women [AOR: 3.2, 95% CI=1.24, 8.12]. Girlswho were less than 16 years of age at first pregnancy had odds2.5 times [AOR=2.5, 95% CI; 1.12, 5.63] higher than all other women to experience MNM. Mothers for whom labor was inducedhad three times the odds [AOR=3; 95%CI; 1.44, 6.17] of being a case as those who were not induced. Mothers who had one prior C-Section had odds four times higher of being a case as those with no history of C-section [AOR= 4, 95% CI; 1.98, 7.61] and those with a history of chronic medical disorder had odds3.5 times higher [AOR=3.5, 95% CI; 1.78, 6.93] of being a case than those without any history. Women who took greater than 60 minute before reaching their final place of care had odds 2.8 times higher of being a case than those who traveled less than 30 minutes [AOR = 2.8,95% CI; 1.19,6.35](Table 5).

Table 5: Predictors of maternal near miss among mothers admitted in public hospitals, Gambela, southwest Ethiopia, 2019. (N=308)

Variables	Maternal near miss		COR[95%]	AOR[95%]
	Cases	Controls		
Residence				
Rural	44(42.7)	45(22)	2.65(1.59,4.42)*	1.4(0.58,3.45)
Urban	59(57.3)	160(78)	1	1
Maternal education				
No formal education	42(40.8)	36(17.6)	4.52(2.395,8.566)	3.2(1.24,8.12)***
Primary	3(2.9)	13(6.3)	0.80(0.213,3.06)	0.6(0.09,3.90)
Secondary	32(31.1)	74(36.1)	1.5 (0.819,2.79)	1.47(0.63,3.41)
More than secondary	24(23.3)	84(41)	1	1

Age at 1st pregnancy				
<16 year	40(38.8)	38(18.5)	3.25(1.79,5.91)*	2.5(1.12,5.63)***
16-19 year	31(30.1)	68(33.2)	1.41(0.78,2.52)*	1(0.48,2.32)
>=20 year	32(31.1)	99(48.3)	1	1
Gravida				
1-2	40(38.8)	97(47.3)	1	1
3-4	20(19.4)	66(32.2)	0.7(0.39,1.36)	0.6(0.29,1.56)
>=5	43(41.7)	42(20.5)	2.48(1.41,4.35)**	2.2(0.91,5.32)
Labour inducement				
Yes	46(44.7)	41(20)	2.31(1.38,3.85)**	3 (1.44,6.17)***
No	57(55.3)	164(80)	1	1
History of chronic disorder				
Yes	57(55.3)	68(33.2)	2.49(1.53,4)*	3.5(1.78,6.93)***
No	46(44.7)	137(66.8)	1	1
History of C-section				
0	48(46.6)	146(71.2)	1	1
>=1	48(46.6)	40(19.5)	3.65(2.14, 6.21)	4.0(1.98,7.61)***
Mode of current delivery				
SVD	18(17.5)	67(32.7)	1	1
Emergency C-section	51(49.5)	64(31.2)	2.9(1.56,5.6)**	1.9(0.72,5.15)
Instrumental	18(17.5)	41(20)	1.63(0.764,3.49)	0.82(0.26,2.55)
Elective C-section	16(15.5)	33(16.1)	1.8(0.81,3.98)	1.1(0.36,3.56)
History of multiple birth				
Yes	55(58.5)	58(36.9)	2.4(1.42,4)**	1.6(0.86,3.22)
No	39(41.5)	99(63.1)	1	1
Referral status				
Yes	50(48.5)	54(26.3)	2(1.2,3.35)**	1.9(1,3.88)
No	53(51.5)	151(73.7)	1	1
Delay at home before seeking obstetric care				
<24 hour	30(29.1)	99(48.3)	1	1
24-36 hour	38(36.9)	66(32.2)	1.9(1.07,3.36)***	0.9(0.42,2.06)
>36 hour	35(34)	40(19.5)	2.88(1.5,5.31)**	1.8(0.77,4.17)
Delay in reaching final place of care				
<30 minute	19(18.4)	62(30.2)	1	1
30-60 minute	22(21.4)	60(29.3)	1.1(0.58,2.43)	0.5(0.19,1.37)
>60 minute	62(60.2)	83(40.5)	2.4(1.32,4.48)***	2.8(1.19,6.35)***

Discussion

This study reveals that lack of formal education, being less than 16 years of age at 1stpregnancy, inducedlabor, history of chronic medical conditions, previous C-section, and having to travel greater than 60 minutes before reaching the final place of care were all determinants of MNM.

The observed association between lack of educational and MNM is consistent with another study in Ethiopia [10], while a study from Brazil showed this was not significant [16]. Education could influence women's overall empowerment, enhancing their ability to make decisions about when and what type of care to pursue. It could increase women's access to relevant information and afford them the financial freedom required to transport themselves to quality services and, if applicable, pay for services. Educated women might be able to more easily absorb health messages through the media and from health professionals. These could collectively influence mothers' awareness to seek better medical services, including delivering in health facilities. Strengthening health interventions targeting women with little or no education might reduce MNM.

Another predictor of MNM is being below 16 years of age at first pregnancy, which is supported by several studies [9, 17, 18]. Younger women may not be physically capable of childbearing. Pregnancy during teenage years also frequently takes place outside the context of marriage, exposing women to adverse social consequences, and thereby possibly contributing to MNM.The Government of Ethiopia is already targeting a reduction in teenage pregnancy from 12% to 3% by 2020, which should be supported [33].

Women with pre-existing chronic conditions had higher odds of MNM in our study, which is consistent with studies in Brazil and the Netherlands [17, 19], though another study in dicatesco-morbidities arenot significantly associated with MNM [20]. For instance, chronic hypertension considerably increases the risk of complications in pregnancy like superimposed pre-eclampsia, placental abruption, intra-uterine growth retardation and pre-term delivery, among other complications [21, 19]. As such, chronic hypertension, diabetes mellitus and cardio-vascular disease in pregnancy may be an indicatorfor referral to a higher facility given that they may expose women to MNM. Pregnant women with any other medical condition need to be carefully monitored and managed during pregnancy in order to prevent potential complications. Creating awareness among mothers on the need for non-communicable disease screening and increasing access to health facilitiesat the grassroots level could be good opportunities to tackle MNM secondary to chronic conditions.

Our study showed the odds of MNM were four times higher among women with previous C-section, which is supported By studies in Brazil and the USA [22, 23].However, a multi-center study showed that C-section may be an acceptable tradeoff in light of the urgency of resolving unfavorable cervical or fetal conditions [24].C-sections are increasingly performed in Brazil and now account for more than half of all deliveries. Among women receiving C-sections in Brazil,

majority are motivated by non-clinical factors [23].

Among cases in our study, 62.5% experienced abruption of the placenta and 60% placenta previa attributed to a previous C-section. Interrupting the pregnancy with a C-sectionin creases the prevalence of infection, hemorrhage, thromboembolism and other complications, which can increase the chance of SAMM and MNM [20, 25]. Prior caesarean births are themselves indications for 'scheduled' caesarean births and, as an invasive procedure, may predispose mothersto stress which could contribute to them experiencing MNM. Previous C-section may also predispose mothers to placenta accrete in scar tissue as well as uterine rupture in attempted vaginal birth after C-section, both of which could lead to increased MNM. Though not fully decided in the literature, our findings might help clinicians and patients consider the risk of procedure and C-sectionmay be advisable when there is a medical indication to improve the outcome of both mother and baby.

Similar to other studies [23, 26], induced labor was associated with MNM in our study. Among cases of induced labor, 33.3% progressed to uterine rupture, suggesting that induction lead to hyper-stimulation of the uterus and then uterine rupture and fetal hypoxia and demise. Inducing labour without medical indication could contribute to MNM. Reviewing contraindications, weighing risks and benefits, and using alternatives to induction may minimize MNM occurrence.

Our study showed that women required to travel greater than 60 minutes to their final point of care were at considerably higher odds of MNM, a finding consistent with studiesin Nigeria and Morocco [12, 15]. Possible reasons for delay include lack of available transport, particularly during night hours, travel distance and lack of roads, seeking care first ata facility that is ill-equipped to provide EMOC, and lack of recognition of the severity of a complication, can all slow a woman's ability to obtain care, contributing to increase rates MNM [6, 9, 27, 28, 29].

Several limitations to our study should be noted. Firstly, our study did not address the determinants of MNM in relation to the quality of obstetric care obtained by cases and controls in terms of structure, process and outcome. The lack of com prehensivedata on the quality obstetric care, including lack of standard izedquality indicators at the facility-level, as well as the cost and short study window make addressing this limitation difficult. Secondly, the disease-specificcriteria weuse to classify MNM arenot always straightforward. For instance, not all women with eclampsia experience MNM and not all women with an obstetric hemorrhage are critically ill, possibly resulting in over-reporting of MNM.

Conclusions

This study identified several factors correlated with women having maternal near miss (MNM). Lack of education, having a first pregnancy before the age of 16, induced labor, history of chronic medical disorder, history of C-section, and delay in reaching the final point of care were all predictors of MNM. Among these, history of chronic medical disorder and C-section, lack of education, and induced labor were the strongest determinants of MNM. The Government of Ethiopia must continue to address structural causes of MNM like lack of road and health facility access, lack of education, and teenage pregnancy. It must simultaneously help women and providers understand determinants of MNM at the facility, community, family and individual levels. Targeted follow-up to women with history of chronic disease and C-section could also be a practical way to reduce MNM.

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Authors' contributions

DE, MA, and GM: initiation of the study, design, analysis and writing of the manuscript. DE, MA and GM: assisted in the design, participated in organizing the data collection process and writing manuscript. All authors read and approved the final manuscript and have equal contribution.

Competing interests

The authors declare that they have no competing interests.

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