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Maternal near misses (MNM) and their determinants among women who sought obstetric care from fort portal regional referral hospital, Western Uganda

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Abstract: Maternal near misses (MNM) involve near-death experiences and are associated with severe maternal morbidity, not limited to severe postpartum haemorrhage, sepsis and organ dysfunction. Maternal near-misses are quite common in Ugandan health facilities. This study aimed to assess the prevalence and determinants of maternal near misses among women who sought obstetric care from Fort Portal Regional Referral Hospital, western Uganda. A retrospective cohort study that targeted 375 women who had received maternal healthcare services from Fort Portal regional referral hospital was undertaken. It was found that, overall, the prevalence of MNM was 61.3%, with sepsis being the commonest determinant [187 (81.3%)]. Eight individual characteristics had statistically significant relationships with MNM; residence type (p = 0.000), trimester of initiation of ANC (p = 0.000), ANC attendance (p = 0.048), delivery of recent pregnancy in health facility (p = 0.000), delivery at Fort Portal regional referral hospital (p = 0.000), referred from other facilities (p = 0.000), age (p = 0.037), marital status (p = 0.000) and district of

Kizito Omona

ABOUT THE AUTHORS

Kizito Omona is a Medical Doctor and Lecturer in the Faculty of Health Sciences (FHS) of Uganda Martyrs University, Kampala. He holds a PhD in Mgt [Healthcare Mgt], Master of Science in Health Services Mgt (MSc. HSM), Master of Science in Monitoring and Evaluation (MSc. M & E), Post Graduate Diploma in Project Planning and Mgt (PGD PPM), Post Graduate Certificate in Project Monitoring and Evaluation (PGC M & E), and Bachelor of Medicine and Bachelor of Surgery (MBChB) degree. He is currently engaged in teaching Public Health and Health Services Management at graduate and post-graduate Levels, Research Supervision in the said areas and levels and community engagement. Research areas are; Clinical Research, Public Health, Maternal and Child Health, Health system research and Child focused research.
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PUBLIC INTEREST STATEMENT

"Maternal near-miss (MNM)" is a condition when a woman nearly dies but survives a complication during pregnancy, childbirth or within 42 days of termination of pregnancy. MNM involves near-death experiences of mothers seeking obstetric care in health facilities. Such experiences, if not treated, can result in maternal death (MD). In Uganda, maternal near misses (MNM) occur more often than maternal deaths which could enable a more comprehensive analysis of risk factors and short-term outcomes during pregnancy and childbirth. In this study, its prevalence was up to 61.3%

residence (p = 0.000). The prevalence of MNM was higher among women who were of rural residence at 45.6% (aPR = 1.409 [1.330–1.493], p = 0.000), compared to those who were of urban residence. MNM prevalence was very high among mothers who never attended ANC at 3.2% and thus, less among those who had attended ANC during pregnancy (cPR = 0.652 [0.216–0.981], p = 0.048). Conclusively, the prevalence of MNM was substantially high.

Subjects: Health & Society; Midwifery; Nursing; Public Health Policy and Practice; Medicine

Keywords: antenatal care; determinants; gravidity; Maternal Near Misses (MNMs); obstructed labour; parity

1. Introduction

1.1. Background of the study

A "maternal near-miss (MNM)" is defined as a condition when a woman nearly dies but survives a complication during pregnancy, childbirth or within 42 days of termination of pregnancy (FIGO, 2019; WHO, 2011). So, MNM involves near-death experiences of mothers seeking obstetric care in health facilities. Such experiences, if not treated, can result in maternal death (MD). MNM is identified using signs of organ dysfunction that followed life-threatening conditions during pregnancy or at childbirth or within 42 days of termination of pregnancy (Mansuri & Mall, 2019; WHO, 2011, 2020a). Women with life-threatening conditions (WLTC) refers to all women who either qualified as maternal near-miss cases or those who died (that is, women presenting a severe maternal outcome). Thus, according to WHO (2011), WLTC is the sum of maternal near-miss and maternal deaths (WLTC = MNM + MD) whereas on the other hand, Severe maternal outcome (SMO) refers to a life-threatening condition (that is, organ dysfunction; Oğlak et al., 2021). MNM predicts almost all cases that progress to maternal mortality and SMO includes all maternal deaths and maternal near-miss cases.

MNM cases have a very high risk of progressing to maternal mortality (Mansuri & Mall, 2019) and so monitoring MNM using WHO-approach would be great help (England et al., 2020). MNM occur up to 20 times more frequent than maternal deaths (Samuels & Ocheke, 2020) and have wide rang of health effects including but not limited to Severe Maternal Morbidity (SMM; (Peker et al., 2020; Samuels & Ocheke, 2020). One characteristic of SMM that antecede maternal near miss is severe postpartum hemorrhage, a leading cause of maternal morbidity and mortality world-wide (Dessalegn et al., 2020; Magar et al., 2020; Mengistu et al., 2020; Mu et al., 2019).

Further still maternal near misses are typified by uterine rupture among other factors (Etuk et al., 2019; Tiwari et al., 2020). Women who experience maternal near misses during pregnancy also have higher chances of experiencing premature rapture of membranes and preterm births (Mengistu et al., 2020), which are among leading predisposing factors for sepsis in maternity ward (Omona, 2021a, 2021b). It should be noted that all the aforementioned characteristics of MNM increase risk of undergoing caesarean sections for both current and future child births (Omona, 2021b; Peker et al., 2020; WHO, 2020a). Additionally, complications associated with MNM are usually managed with interventions such as hysterectomy, among others (Pillarisetty & Mahdy, 2020; Taylor & Pillarisetty, 2020) and this further affects future conception (Peker et al., 2020). It is unsurprising therefore, that MNMs are significant causes of poor maternal health outcomes (Mengistu et al., 2020), and a poor reproductive health quality of life.

Maternal near misses, are currently considered to be the most appropriate indicators of obstetric care (Filippi et al., 2018; Owolabi et al., 2020; Ugwu et al., 2020), whose assessment can inform mortality preventive interventions.

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The global prevalence of MNM has been reported to be 18.67/1000 live births, ranging from 3.10/1000 in the Europe to 16.92/1000 in Asia. The prevalence is 11.57/1000 in South America and 31.88/1000 in Africa (Abdollahpour et al., 2019). In Turkey, the MNM ratio was 5.06 patients per 1000 live births (Oğlak et al., 2021). Therefore, it is feared that MNM could hamper the global achievement of Sustainable Development Goal 3 (SDG target 3.1).

However, across Africa there are variations in the prevalence of MNM, ranging from 5%—7% in the horn of Africa (Kumela et al., 2020; Yeman et al., 2020) and 0.3%—8.8% in West Africa (Etuk et al., 2019; Owolabi et al., 2020; Sotunsa et al., 2019; Ugwu et al., 2020, Okwaraji, et al., 2015). In East Africa, the prevalence ranges from 4% to 30% (Lilungulu et al., 2020; Nakimuli et al., 2016).

In Uganda, a study by Nakimuli et al. (2016) found the prevalence of MNM to be 22.7% and in another study, it was 287.7 per 1000 pregnancies (Nansubuga et al., 2016) although in an earlier study by Nansubuga and Ayiga (2015) it was found to be 27% (0.027 per 1,000 pregnancies). Other studies found similar results on the impact of MNM (Okonh et al., 2006).

This study aimed to assess the prevalence and determinants of maternal near misses among women in Fort Portal Regional Referral Hospital, Western Uganda. Fort Portal regional referral hospital has had and still has one of the highest maternal mortality rates registered annually, among regional referral hospitals in Uganda, according to the Health Monitoring Unit (HMU). No documentation of the prevalence of MNM at many hospitals, despite evidence of their overt occurrence, hence the need for this study in Fort Portal Regional Referral Hospital.

1.2. Research questions

The study sought answers to the following research question

(1) What was the prevalence of maternal near misses among women who sought obstetric care from Fort Portal Regional Referral Hospital, Western Uganda?

(2) What was the distribution of maternal near misses among women who sought obstetric care from Fort Portal Regional Referral Hospital, Western Uganda?

(3) What were the individual determinants of maternal near misses among women who sought obstetric care from Fort Portal Regional Referral Hospital, Western Uganda?

(4) What were the obstetric determinants of maternal near misses among women who sought obstetric care from Fort Portal Regional Referral Hospital, Western Uganda?

2. Materials & methods

2.1. Study design

This study adopted a retrospective cohort design, to study the determinants of maternal near misses among women who seek obstetric care from Fort Portal regional hospital. The design matched closely with retrospective chart review design involved the abstraction of clinical data from a set of patient records (Worster and Haines, 2004). Clinical data from electronic databases, diagnostic tests, health service provider notes (Vassar and Holzmann, 2013), were used as necessary.

2.2. Study area

The study was conducted in Fort portal hospital. Fort portal hospital is a 300-bed public regional referral hospital, located in Kabarole District, in Western Uganda. The hospital is a referral health facility for six districts; Bundibugyo, Kyenjojo, Kamwenge, Kabarole, Ntoroko and Kasese. It provides all types of health care including general health care, surgery, intensive care services, and maternal health care services, for a catchment population of over 2 million people (Kabarole District, 2020).

2.3. Study population

The study targeted women who had received or sought obstetric care from Fort portal regional referral hospital between the years 2017 and 2019.

2.4. Eligibility for inclusion

The study included women whose antenatal care, skilled birth attendance, and postnatal care records was available at the hospital, irrespective of whether one had received all the three services. or some of them from the hospital. Women whose records were missing were excluded.

2.5. Sample size determination

The computation of the sample size for this study ensured maximum power as required in retrospective studies (Vassar and Holzmann, 2013). We used the target population size (N) as substitution parameter. This required that a formula by Krejcie and Morgan had to be used;

$$\mathbf{s} = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)}$$

Where;

s = required sample size

X^2 = the table value of chi-square for 1 degree of freedom at the desired confidence level (3.841).

N = the population size = the number of women who received obstetric care from Fort Portal regional referral hospital between the years 2017 and 2019 = 15,720

P = the population proportion (assumed to be 50% since this would provide the maximum sample size) = 50% = 0.5

d = the degree of accuracy expressed as a proportion = 5% = 0.05

Thus,

$$\mathrm{s} = \frac{1.96^2 \,\mathrm{x}\, 15720 \,\mathrm{x}\, 0.50 \,\mathrm{x}\, (1 - 0.5)}{0.05^2\ (15720 - 1) + 1.96^2 \mathrm{x} 0.5\ (1 - 0.5)}$$

$$\mathrm{s} = \frac{3.8416 \,\mathrm{x}\, 15720 \,\mathrm{x}\, 0.25}{0.0025\ (15720 - 1) + 3.8416 \,\mathrm{x}\, 0.25} = \frac{15095.3}{39.2975 + 0.9603} = \frac{15095.3}{40.25775} = 375\ \textit{Women}$$

2.6. Sampling procedures

Fort portal regional referral hospital was purposively sampled. The fact that the study was conducted at only one facility, with interest in only one department (maternity), the sampling process was conducted at a single stage, that is, at the aforementioned department. We requested all clinical records of mothers who received antenatal care and delivered from the facility between the years 2017 and 2019 to be availed. Upon reception of those clinical records, that was in upwards of 3000, they were split into batches of 1000, in order to make the sampling process more manageable. Given the large number of patient files, it was feasible to use a systematic random sampling. With this technique, a sampling interval was calculated, so as to determine the skip (K), that will have to be observed. The sampling interval was calculated using the formula; $K = \frac{N}{n}$, where;

K = Sampling interval, N = Target sample size at facility, n = Sample size

The formula yielded an interval of; $K = \frac{(3672)}{(375)} = 9.7 \approx 10$

We then started the sampling process, in which the first file (on top of the pile) was made the starting point. The interval (skip) of 10 was observed and the next file sampled. This process was continued until 375 patients are sampled. The sampled files were each screened for eligibility, and any file found to be illegible was replaced immediately.

2.7. Operation definitions

In this study, the following terms were defined as under;

(1) **Maternal near-miss (MNM)** refers to a woman who nearly died but survived a complication that occurred during pregnancy, childbirth or within 42 days of termination of pregnancy (Oğlak et al., 2021; WHO, 2011).

(2) **Maternal death (MD)** is the death of a woman while pregnant or within 42 days of termination of pregnancy or its management, but not from accidental or incidental causes (WHO, 2011).

(3) **Live birth (LB)** refers to the birth of an offspring which breathes or shows evidence of life (Oğlak et al., 2021; WHO, 2011).

(4) **Severe maternal outcome (SMO)** refers to a life-threatening condition (i.e. organ dysfunction), including all maternal deaths and maternal near-miss cases (Oğlak et al., 2021; WHO, 2011).

(5) **Women with life-threatening conditions (WLTC)** refers to all women who either qualified as maternal near-miss cases or those who died (i.e. women presenting a severe maternal outcome). It is the sum of maternal near-miss and maternal deaths (WLTC = MNM + MD; WHO, 2011).

(6) **Severe postpartum haemorrhage**; refers to genital bleeding after delivery, with at least one of the following: perceived abnormal bleeding (1000 ml or more) or any bleeding with hypotension or blood transfusion (WHO, 2011).

(7) **Severe pre-eclampsia**; refers to persistent systolic blood pressure of 160 mmHg or more or a diastolic blood pressure of 110 mmHg; proteinuria of 5 g or more in 24 hours; oliguria of oliguria of <400 ml in 24 hours; and HELLP syndrome or pulmonary oedema. It excludes eclampsia (Oğlak et al., 2021; WHO, 2011).

(8) **Eclampsia**; refers to generalized fits in a patient without previous history of epilepsy. It includes coma in pre-eclampsia (WHO, 2011).

(9) **Severe systemic infection or sepsis**; refers to the presence of fever (body temperature >38°C), a confirmed or suspected infection (e.g., chorioamnionitis, septic abortion, endometritis, pneumonia), and at least one of the following: heart rate >90, respiratory rate >20, leukopenia (white blood cells 12 000; Omona, 2021b; WHO, 2011).

(10) **Uterine rupture**; refers to the rupture of uterus during labour confirmed by laparotomy (WHO, 2011).

(11) **Shock index (SI)** is a bedside assessment defined as heart rate divided by systolic blood pressure, with a normal range of 0.5 to 0.7 in healthy adults (Berger et al., 2013).

2.8. Data collection

We abstracted information from the patients' medical records—medical record abstraction (MRA). We then made direct matching of information in a given patient record, with the entry required on the data abstraction form (Zozus et al., 2019). The data abstraction form was designed in a structured manner that is, with close ended items that later made it easier to

quantify and come up with inferences. During the process, categorization of information in the records, selection of one that is of importance at an instance, interpreting and summarizing the information was made. Each of the eligible patient files/records was then checked for indicators of interest, which if found was abstracted, and matched with the items on the form. Our data abstraction form had four sections; (A) Socio-demographic variables, (B) maternal near miss indicators/variables of investigation, (C) individual condition variables, and (D) obstetric variables.

2.9. Quality controls

Data abstraction training—Retrospective chart review studies are some of the most error prone studies (Zozus et al., 2019), given that data accuracy remains an issue of concern, during the medical record abstraction. That can however be prevented with apt quality control measures (Zozus et al., 2015, 2019), which for MRAs primarily involves record abstraction assistant training. The fact that this study had a sampling frame of about 5000 women implies that the principal investigator had to have some

Three data abstraction assistants, all graduates, with clinical background and prior experience with medical record abstraction (MRA) were recruited and trained. This was to assist with the sampling and eligibility screening for each patient record and final MRA. The training was followed with actual medical record abstraction drills, in which each of the assistant was provided with sample patient files, from one of the health center IVs in Kabarole district, and taken through the MRA process that was adopted in the study. A second drill was then conducted, in which each assistant was still given a sample patient file to abstract, and an evaluation of his work was still conducted.

Inter-rater reliability—We also assessed the Inter-rater reliability. We carried out MRA using the same medical records that the research assistants had been given earlier. A comparison with the forms earlier filled by the assistants was made. This re-abstraction exercise was used to identify discrepancies, which made it a measure of reliability and a surrogate for data accuracy (Zozus et al., 2019). Reliability was affirmed when a high consistency was observed between the re-abstracted data and the data earlier captured by the research assistants.

Pretesting—A pretest of the data abstraction form was also conducted. We were interested in (1) determining the duration of each MRA (2) determining whether there was need to have any more item(s) (3) determining appropriateness of each of the items in the abstraction and (4) further orienting the abstraction assistants. The pretest was conducted at Kabarole district hospital. In cases of any errors in the items with the abstraction form, they were corrected prior to the MRA at the study site (Fort Portal regional referral hospital).

2.10. Data entry, analysis and presentation

Data was checked for completeness and validity and then carefully entered into SPSS version 25 for analysis. Univariate, Bivariate and multivariate analysis was made. Relationship analysis was conducted using the robust Poisson regression model. There was no adjustment for confounders, and therefore, only a pair of variables (one independent and the dependent) was analyzed, yielding three outputs, that is, p-values, a crude prevalence ratio (cPR) and confidence intervals (CI). Statistical significance was set at 5% (0.05), for which all p-values that was found to be less than 0.05 was considered statistically significant. Every variable that was found to be statistically significant at bivariate level was fitted into a multivariate robust Poisson distribution, each with appropriate potential covariates; which yielded three outputs including adjusted prevalence ratios (aPR).

2.11. Ethical considerations

The required ethical approval for the study was sought and granted by Uganda Martyrs University Ethics Committee, through Faculty of Health Sciences. Subsequent approval was obtained from the IRB of Fort Portal Regional Referral Hospital. Other ethical considerations observed included consent, confidentiality and anonymity.

3. Results

We managed to abstract 453 files and excluded 78 files. The excluded files had incomplete information as per our data abstraction sheet (See appendix for the data abstraction form). The remaining 375 files were then analyzed.

3.1. Socio-demographic characteristics of respondents

More than two thirds of the women whose maternity records were reviewed were in the in the adolescent and young people category, aged between 15 and 25 years 264(70.4%). Almost a third of them were Catholics 117(31.2%), and close to thirds of them were married 236(62.9%). Almost all the women whose records were reviewed had reportedly received formal education 366(97.6%). Almost three quarters of them were not employed 276(73.6%). Slightly more than two thirds of the women were from Kabarole district 134(35.7%)

3.2. Prevalence of Maternal Near Misses (MNMs)

Figure 1 presents findings that were obtained following the quantification of the prevalence of maternal near misses (MNMs). It was found that the majority of the women 230 (61.3%) had experienced a maternal near miss.

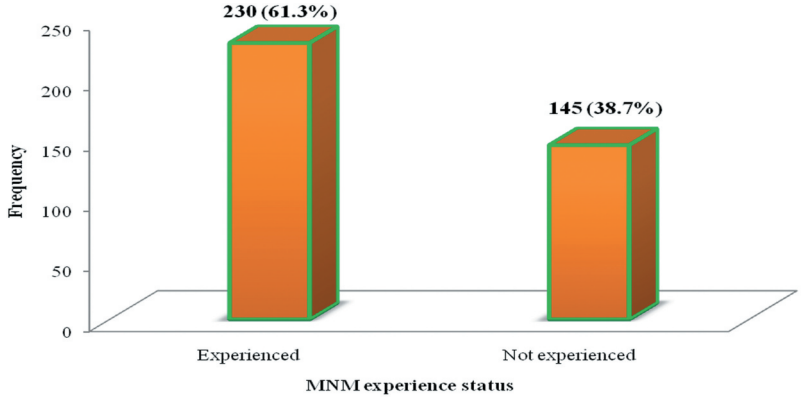

Figure 1. Prevalence of MNMs among women who sought obstetric care.

3.3. Distribution of MNMs among mothers

Maternal near misses were distributed as shown in Table 1 and 2.

Table 2 presents distribution of MNM among mothers. The findings indicated that among the women who experienced maternal near misses more than three quarter of them had sepsis (81.3%). This makes sepsis the most prevalent indicator of maternal near misses. The second most prevalence indicator of maternal near misses was severe complications of abortion 143 (62.2%), followed by severe systemic infection 107(46.5%), and eclampsia, 105(45.7%).

Table 1. Socio demographic characteristics of the women (n =375)

Variable	Frequency	Percentage (%)
Age		
• 15–25 years	264	70.4
• 26–36 years	99	26.4
• 37–47 years	12	3.2
		100.0
Religion		
• Catholic	117	31.2
• Muslim	64	17.1
• Anglican	106	28.3
• SDA	72	19.2
• Born again	16	4.3
		100.0
Marital Status		
• Married	236	62.9
• Single	54	14.4
• Cohabiting	85	22.7
		100.0
Received formal education		
• Yes	366	97.6
• No	9	2.4
		100.0
Employment Status		
• Employed	99	26.4
• Not employed	276	73.6
		100.0
District of residence		
• Kabarole	134	35.7
• Kasese	37	9.9
• Ntoroko	60	16.0
• Bundibugyo	12	3.2
• Kyenjojo	96	25.6
• Kamwenge	12	3.2
• Kyegegwa	24	6.4
		100.0

Table 2. Distribution of MNM Variables among Mothers

MNM Variables	MNMs		Total
	Experienced [n = 230]	Didn't experience [n = 135]	
Postpartum hemorrhage			
• Experienced (between 500 ml and 1000 ml)	71(30.9%)	2(1.4%)	73(19.5%)
• Experienced (More than 1000 ml)	0(0.0%)	6(4.1%)	6(1.6%)
• Not experienced	159(69.1%)	137(94.5%)	296(78.9%)
Severe preeclampsia			
• Experienced	93(40.4%)	4(2.8%)	97(25.9%)
• Not experienced	137(59.6%)	141(97.2%)	278(74.1%)
Eclampsia			
• Experienced	105(45.7%)	3(2.1%)	108(28.8%)
• Not experienced	125(54.3%)	142(97.9%)	267(71.2%)
Sepsis			
• Experienced	187(81.3%)	7(4.8%)	194(51.7%)
• Not experienced	43(18.7%)	138(95.2%)	181(48.3%)
Severe systemic infection			
• Experienced	107(46.5%)	2(1.4%)	109(29.1%)
• Not experienced	123(53.5%)	143(98.6%)	266(70.9%)
Ruptured uterus			
• Experienced	88(38.3%)	3(2.1%)	91(24.3%)
• Not experienced	142(61.7%)	142(97.9%)	284(75.7%)
Severe complications of abortion			
• Experienced	143(62.2%)	6(4.1%)	149(39.7%)
• Not experienced	87(37.8%)	139(95.9%)	226(60.3%)
Cardiovascular dysfunction			
• Shock	1(0.4%)	0(0.0%)	1(0.3%)
• Cardiac arrest (absence of pulse/ heart beat and loss of consciousness)	14(6.1%)	2(1.4%)	16(4.3%)
• Not experienced	215(93.5%)	143(98.6%)	358(95.5%)
Respiratory dysfunction			

(*Continued*)

MNM Variables	MNMs		Total
	Experienced [n = 230]	Didn't experience [n = 135]	
• Gasping	1(0.4%)	0(0.0%)	1(0.3%)
• Not experienced	229(99.6%)	145(100.0%)	374(99.7%)
Renal dysfunction			
• Not experienced • Experience	230(100.0%) 0(0.0%)	145(100.0%) 0(0.0%)	375(100.0%) 0(0.0%)
Coagulation/ haematological dysfunction			
• Not experienced • Experienced	230(100.0%) 0(0.0%)	145(100.0%) 0(0.0%)	375(100.0%) 0(0.0%)
Hepatic dysfunction			
• Jaundice in the presence of pre-eclampsia	47(20.4%)	2(1.4%)	49(13.1%)
• Severe acute hyperbilirubinemia (bilirubin >100 µmol/l or >6.0 mg/dl)	4(1.7%)	0(0.0%)	4(1.1%)
• Not experienced	179(77.8%)	143(98.6%)	322(85.9%)
Neurological dysfunction			
• Not experienced • Experienced	230(100.0%) 0(0.0%)	145(100.0%) 0(0.0%)	375(100.0%) 0(0.0%)
Uterine dysfunction			
• Uterine haemorrhage or infection leading to hysterectomy	15(6.5%)	1(0.7%)	16(4.3%)
• Not experienced	215(93.5%)	144(99.3%)	359(95.7%)

3.4. Individual determinants of maternal near misses

Bivariate analysis was done to determine individual determinants of MNM among mothers. See, Table 3 for details of the results.

More than four fifths of the women sampled were resident in rural settings 314 (83.7%). More than a third of the women attended their 4th ANC visit during the previous pregnancy [136 (36.3%)], while slightly more than three quarters of them had initiated ANC during the first trimester [288 (76.8%)]. More than four fifths of the women had delivered their most recent pregnancies in a health facility setting [324 (86.4%)], with almost the same proportion being delivered at Fort Portal hospital [309 (82.4%)]. More than four fifths of the women had been admitted in the hospital for less than 3 days [344 (91.7%)]. Slightly more than a third of them had been referred from other facilities [253 (67.5%)].

Table 3. Unadjusted relationships between individual variables and MNMs

Variable	Total	MNM status		cPR (95% CI)	P-value
		Experienced [n = 230]	Didn't experience [n = 145]		
Residence type					
• Rural	314	171(45.6%)	143(38.1%)	1.409 (1.330–1.493)	0.000
• Urban	61	59(15.7%)	2(0.5%)	Ref	
ANC during pregnancy					
• Yes	362	218(58.1%)	144(38.4%)	0.652(0.216–0.981)	0.048
• No	13	12(3.2%)	1(0.3%)	Ref	
Frequency of ANC attendance					
• One visit	46	28(7.5%)	18(4.8%)	1.026 (0.896–1.175)	0.710
• Two visits	37	23(6.1%)	14(3.7%)	1.017 (0.880–1.175)	0.824
• Three visits	97	64(17.1%)	33(8.8%)	0.988 (0.882–1.108)	0.841
• Four visits	136	77(20.5%)	59(15.7%)	1.057 (0.950–1.177)	0.307
• More than four visits	59	38(10.1%)	21(5.6%)	Ref	
Trimester of Initiation of ANC					
• First trimester	288	173(46.1%)	114(30.4%)	0.705 (0.418–0.970)	0.001
• Second trimester	32	9(2.4%)	23(6.1%)	0.329 (0.223–0.795)	0.000
• Third trimester	55	47(12.5%)	8(2.1%)	Ref	
Delivered recent pregnancy in health facility					
• Yes	324	185(49.3%)	139(37.1%)	0.647 (0.374–0.828)	0.000
• No	51	45(12.0%)	6(1.6%)	Ref	
Delivered at Fort Portal hospital					
• Yes	309	167(44.5%)	142(37.9%)	0.565 (0.217–0.821)	0.000
• No	66	63(16.8%)	3(0.8%)	Ref	
Length of hospital stay					

(*Continued*)

Variable	Total	MNM status		cPR (95% CI)	P-value
		Experienced [n = 230]	Didn't experience [n = 145]		
• More than 3 days	31	20(5.3%)	11(2.9%)	0.975 (0.856–1.110)	0.702
• Less than 3 days	344	210(56.0%)	134(35.7%)	Ref	
Referred from other facilities					
• Yes	253	20(5.3%)	11(2.9%)	1.498 (1.215–1.848)	0.000
• No	122	210(56.0%)	134(35.7%)	Ref	
Age					
• Between 15 and 25 years	264	165(44.0%)	99(26.4%)	0.152 (0.019 −1.191)	0.073
• Between 26 and 36 years	99	54(14.4%)	45(12.0%)	0.109 (9.014–0.878)	0.037
• Between 37 and 47 years	12	11(2.9%)	1(0.3%)	Ref	
Religion					
• Catholic	117	67(17.9%)	50(13.3%)	1.088 (0.905–1.307)	0.372
• Muslim	64	28(7.5%)	36(9.6%)	1.190 (0.985–1.439)	0.072
• Anglican	106	76(20.3%)	30(8.0%)	0.978 (0.812–1.177)	0.810
• SDA	72	48(12.8%)	24(6.4%)	1.016 (0.839–1.230)	0.872
• Born again	16	11(2.9%)	5(1.3%)	Ref	
Marital Status					
• Married	236	155(41.3%)	81(21.6%)	4.342 (2.546–7.406)	0.000
• Single	54	49(13.1%)	5(1.3%)	22.238 (7.945–62.250)	0.000
• Cohabiting	85	26(6.9%)	59(15.7%)	Ref	
Received formal education					
• Yes	366	224(59.7%)	142(37.9%)	1.041 (0.824–1.315)	0.736
• No	9	6(1.6%)	3(0.8%)	Ref	
Employment Status					

(*Continued*)

Table 3. (*Continued*)

Variable	Total	MNM status		cPR (95% CI)	P-value
		Experienced [n = 230]	Didn't experience [n = 145]		
• Employed	99	67(17.9%)	32(8.5%)	0.939 (0.866–1.018)	0.126
• Not employed	276	163(43.5%)	113(30.1%)	Ref	
District of residence					
• Kabarole	134	71(18.9%)	63(16.8%)	0.767 (0.707–0.832)	0.000
• Kasese	37	35(9.3%)	2(0.5%)	0.550 (0.503–0.602)	0.000
• Ntoroko	60	36(9.6%)	24(6.4%)	0.730 (0.657–0.812)	0.000
• Bundibugyo	12	1(0.3%)	11(2.9%)	1.000 (0.905–1.105)	0.000
• Kyenjojo	96	83(22.1%)	13(3.5%)	0.592 (0.545—.644)	0.000
• Kamwenge	12	2(0.5%)	10(2.7%)	0.957 (0.841–1.088)	0.498
• Kyegegwa	24	2(0.5%)	22(5.9%)	Ref	

Eight individual characteristics had statistically significant relationships with the incidence of maternal near misses. They included residence type (p = 0.000), trimester of initiation of ANC (p = 0.000), ANC attendance (p = 0.048), delivery of recent pregnancy in health facility (p = 0.000), delivered at fort portal hospital (p = 0.000), referred from other facilities (p =0.000), age (p = 0.037), marital status (p = 0.000) and district of residence (p = 0.000). The findings showed that the prevalence of MNM was higher among women who were rural residents at 45.6% (aPR = 1.409 [1.330–1.493], p = 0.000), compared to those who were in urban areas. The prevalence of MNM was very high among mothers who never attended ANC at 3.2%) and thus, less among those who had attended ANC during pregnancy (cPR = 0.652 [0.216–0.981], p = 0.048). Maternal near miss incidence was less among women who initiated ANC in the second trimester (cPR = 0.329, CI = 0.223–0.795), P = 0.000) compared to those who initiated in the third trimester. It was less among women who had delivered their most recent pregnancy in a health facility (cPR = 0.170, CI = 0.074–0.428], p = 0.000) compared to those who had not delivered in a health facility. Women who had been delivered at Fort Portal hospital exhibited 44.5% prevalence of MNM (cPR = 0.056 [0.017–0.182], p = 0.000) compared to those who had been delivered from elsewhere. In fact, women who had been referred from other facilities had 5.3% prevalence of MNM (cPR = 1.498 [1.215–1.848], p = 0.000) compared to those who had been delivered (not referred) at Fort Portal hospital. Women who were between the ages of 26 and 36 years at risk of MNM (cPR = 0.109 [9.014–0.878, p = 0.037) compared to those who were between 37 and 47 years. Single women exhibited 13.1% prevalence of MNM compared to those who were not single. Maternal Near Miss incidence was at 9.3% among women who were from Kasese district (cPR = 0.550 [0.503–0.602], p = 0.000) and 9.6% among women from Ntoroko.

3.5. Obstetric Determinants of Maternal Near Misses

Bivariate analysis was done to determine obstetric determinants of MNM among mothers. See, Table 4 for details of the results.

Table 4. Unadjusted relationships between obstetric variables and MNM

Obstetric Variables	Total	MNM status		cPR (95% CI)	*P-value*
		Experienced [n = 230]	Not experienced [n = 145]		
Nature of pregnancy					
• Multiple	24	12(3.2%)	12(3.2%)	1.088 (0.947–1.249)	0.233
• Singleton	351	218(58.1%)	133(35.5%)	Ref	
Previous cesarean delivery					
• Yes	215	105(28.0%)	110(29.3%)	0.267 (0.169–0.424)	0.000
• No	160	125(33.3%)	35(21.9%)	Ref	
Number of cesarean deliveries					
• One	33	32(8.5%)	1(0.3%)	0.706 (0.632–0.790)	0.000
• Two	124	36(9.6%)	88(23.5%)	1.172 (1.053–1.305)	0.004
• Three	48	26(6.9%)	22(5.9%)	Ref	
Type of most recent cesarean delivery (n =215)				N.A	
• Emergency	162	51(13.6%)	111(29.6%)		
• Elective	53	52(13.9%)	1(0.3%)		
Duration of labor					
• Less than 5 hours	76	71(18.9%)	5(1.3%)	2.819 (2.14–3.703)	0.000
• More than 5 hours	299	159(42.4%)	140(37.3%)	Ref	

(*Continued*)

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Table 4. (*Continued*)

Obstetric Variables	Total	MNM status		cPR (95% CI)	*P-value*
		Experienced [n = 230]	Not experienced [n = 145]		
Labour induced					
• Yes	238	191(50.9%)	47(19.7%)	13.019 (5.115–33.138)	0.000
• No	137	39(10.4%)	98(26.1%)	Ref	
Labour obstructed					
• Yes	78	73(19.5%)	5(1.3%)	1.931 (1.629–2.290)	0.000
• No	297	157(41.9%)	140(37.3%)	Ref	
Gravidity					
• One	125	102(27.2%)	23(6.1%)	1.677 (1.192–2.360)	0.003
• Two	117	71(18.9%)	46(12.3%)	1.247 (0.869–1.791	0.231
• Three	96	39(10.4%)	57(15.2%)	0.835 (0.554–1.258	0.389
• More than three	37	18(9.9%)	19(5.1%)	Ref	
Still birth history					
• Yes	3	1(0.3%)	2(0.5%)	1.204 (0.872–1.661)	0.259
• No	372	229(61.1%)	143(38.1%)	Ref	
Parity					
• One	275	156(41.6%)	119(31.7%)	0.767 (0.656–0.895)	0.001

(*Continued*)

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Table 4. (*Continued*)

	Total	**MNM status**			
Obstetric Variables		**Experienced [n = 230]**	**Not experienced [n = 145]**	**cPR (95% CI)**	***P-value***
• More than one	100	74(19.7%)	26(6.9%)	Ref	
Outcomes of pregnancy				N.A	
• Spontaneous abortion	13	11(3.5%)	2(0.5%)		
• Induced abortion	24	24(6.4%)	0(0.0%)		
• Live birth	326	183(48.8%)	143(38.1%)		
• Still birth	12	12(3.2%)	0(0.0%)		

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More than four fifths of the women whose records were reviewed had had singleton pregnancies [351(93.6%)], while more than half of them had been delivered via cesarean delivery [215(57.3%)]. The majority of those mothers had had two cesarean deliveries done [124(60.5%)], with the commonest type being emergency cesarean section [162(75.7%)]. Almost two thirds of the women had been in labor for more than 5 hours [299(79.7%)]. More than half of the women did not experience obstructed labor [297(79.2%)]. More than four fifths of the women had had live births from their previous pregnancies [326(86.9%)].

The prevalence of MNM was at 28.0% among women who had had a previous cesarean delivery (cPR = 0.267 [0.169–0.424], p = 0.000) compared to those who did not have a previous cesarean delivery. The prevalence was higher at 9.6% among those who had had two cesarean deliveries (cPR = 1.172 [1.053–1.305], p = 0.004) compared to those who had had three cesarean deliveries. The prevalence of MNM was at 42.4% among women who were in labor for more than 5 hours (cPR = 2.819 [2.14–3.703], p = 0.000). This is much higher (two time higher) as compared to those mothers who were in labor for less than 5 hours. The prevalence of MNM was at 50.9% among women whose labour had been induced. This is much higher, about 5times higher, compared to mothers whose labour was not induced. Result futher showed that mothers whose was induced were 13times more likely to experience MNM (cPR = 13.019 [5.115–33.138], p = 0.000) compared to those whose labor had not been induced. Obstructed labour was found to be associated with MNM (cPR = 1.931 [1.629–2.290], p = 0.000). Gravida one women had a higher risk of MNM incidence (cPR = 1.677 [1.192–2.360], p = 0.003) compared to those who had carried more than three pregnancies at the time. Parity of women was found to be associated with MNM (cPR = 0.767 [0.656–0.895], p = 0.001).

3.6. Multivariate analysis for MNM

From Table 5, the variables that were found to be of statistical significance, include residence type, ANC during pregnancy, delivered at Fort Portal hospital, referral from other facilities, age, and marital status, and previous cesarean delivery, number of cesarean deliveries, duration of labor, labor induced and gravidity. The prevalence of MNM was 47% higher among rural women (aPR = 1.470 (1.358–1.591), p = 0.000), compared to women from urban residence women.

The prevalence of MNM incidence was higher by 41% among women who had delivered at Fort Portal hospital (aPR = 0.502 [0.014–0.194], p = 0.000) compared to those who had been delivered at other facilities, prior to being referred to Fort portal hospital. Women who had been referred from other facilities (aPR = 5.431 [2.777–10.622], p = 0.000) compared to those who not been referred to Fort Portal hospital. Women who were single (aPR = 28.436 [9.560–84.579], p = 0.007) were 28times more likely to experience MNM compared to those who were married or co-habiting. Women who had been in labour for less than 5 hours were 7 times more likely to experience MNM (aPR = 7.219 [4.365–11.938], P = 0.000) compared to those who had been in labor for more than 5 hours. Women who had their labour induced were 15 times more likely to experience MNM (aPR = 15.676 [3.708–66.272], p = 0.000) compared to those whose labour was not induced. Gravida one women were two times more likely to experience MNM (aPR = 1.989 [1.420–2.787], p = 0.000) compared to mothers with higher gravidity.

3.7. Summary of results

Overall, the prevalence of MNM was 61.3%, with sepsis being the commonest determinant [187(81.3%)]. Eight individual characteristics had statistically significant relationships with MNMs; residence type (p = 0.000), trimester of initiation of ANC (p = 0.000), ANC attendance (p = 0.048), delivery of recent pregnancy in health facility (p = 0.000), delivery at fort portal hospital (p = 0.000), referred from other facilities (p = 0.000), age (p = 0.037), marital status (p =0.000) and district of residence (p = 0.000). The prevalence of MNM was higher among women who were of rural residence at 45.6% (aPR = 1.409 [1.330–1.493], p = 0.000), compared to those who were of urban residence. The prevalence was very high among mothers who never attended ANC at 3.2% and thus, less among those who had attended ANC during pregnancy (cPR = 0.652 [0.216–0.981], p = 0.048). Obstructed labour was found to be a determinant of MNM (cPR = 1.931 [1.629–2.290], p = 0.000). Gravida one women had a higher risk of MNM incidence (cPR = 1.677

Table 5. Determinants of maternal near misses among women who sought obstetric care

Variables	cPR (95% CI)	P-value	aPR (95% CI)	P-value
Residence type				
• Rural	1.409 (1.330–1.493)	0.000	1.470 (1.358–1.591)	0.000
• Urban	Ref		Ref	
ANC during pregnancy				
• Yes	0.652(0.216–0.981)	0.048	0.307 (0.038–2.509)	0.271
• No	Ref		Ref	
Trimester of Initiation of ANC				
• First trimester	0.705 (0.418–0.970)	0.001	0.749 (0.161–3.492)	0.713
• Second trimester	0.329 (0.223–0.795)	0.000	0.480 (0.115–1.999)	0.313
• Third trimester	Ref		Ref	
Delivered pregnancy in health facility				
• Yes	0.647 (0.374–0.828)	0.000	0.342 (0.108–1.083)	0.068
• No	Ref		Ref	
Delivered at Fort Portal hospital				
• Yes	0.565 (0.217–0.821)	0.000	0.502 (0.014–0.194)	0.000
• No	Ref		Ref	
Referred from other facilities				
• Yes	1.498 (1.215–1.848)	0.000	5.431 (2.777–10.622)	0.000
• No	Ref		Ref	
Age				
• Between 15 and 25 years	0.152 (0.019 –1.191)	0.073	0.238(0.016–3.585)	0.300
• Between 26 and 36 years	0.109 (9.014–0.878)	0.037	0.352(0.032–3.895)	0.395
• Between 37 and 47 years	Ref		Ref	
Marital Status				
• Married	4.342 (2.546–7.406)	0.000	7.137 (3.715–13.713	0.000
• Single	22.238 (7.945–62.250)	0.000	28.436 (9.560–84.579	0.000
• Cohabiting	Ref		Ref	

(*Continued*)

Table 5. (*Continued*)

Variables	cPR (95% CI)	P-value	aPR (95% CI)	P-value
District of residence				
• Kabarole	0.767 (0.707–0.832)	0.000	0.947 (0.831–1.080)	0.419
• Kasese	0.550 (0.503–0.602)	0.000	0.690 (0.602–0.791)	0.000
• Ntoroko	0.730 (0.657–0.812)	0.000	0.995 (0.879–1.127)	0.942
• Bundibugyo	1.000 (0.905–1.105)	1.000	1.457 (1.152 –1.843)	0.002
• Kyenjojo	0.592 (0.545—.644)	0.000	0.744 (0.642–0.861)	0.000
• Kamwenge	0.957 (0.841–1.088)	0.498	1.315 (1.062–1.627)	0.012
• Kyegegwa	Ref		Ref	
Previous cesarean delivery				
• Yes	0.267 (0.169–0.424)	0.000	0.488 (0.291–.819)	0.007
• No	Ref		Ref	
Number of cesarean deliveries				
• One	0.706 (0.632–0.790)	0.000	0.077 (0.000–16.169	0.348
• Two	1.172 (1.053–1.305)	0.004	1.105 (1.110–1.282)	0.001
• Three	Ref		Ref	
Duration of labour				
• Less than 5 hours	2.819 (2.140–3.703)	0.000	7.219 (4.365–11.938)	0.000
• More than 5 hours	Ref		Ref	
Labor induced				
• Yes	13.019 (5.115–33.138)	0.000	15.676 (3.708–66.272)	0.000
• No	Ref		Ref	
Labor obstructed				
• Yes		0.000	0.973 (0.867–1.091)	0.638
• No	Ref		Ref	
Gravidity				
• One	1.677 (1.192–2.360)	0.003	1.989 (1.420–2.787	0.000
• Two	1.247 (0.869–1.791)	0.231	1.247 (0.869–1.791)	0.231
• Three	0.835 (0.554–1.258)	0.389	0.846 (0.562–1.274)	0.424
• More than three	Ref			
Parity				

(*Continued*)

Variables	cPR (95% CI)	P-value	aPR (95% CI)	P-value
• One	0.767 (0.656–0.895)	0.001	0.600 (0.339–1.062)	0.080
• More than one	Ref		Ref	

[1.192–2.360], p = 0.003) compared to those who had carried more than three pregnancies at the time. Parity of women was found to be associated with MNM (cPR = 0.767 [0.656–0.895], p = 0.001).

4. Discussion

4.1. Prevalence of MNMs

Whereas the maternal mortality has gradually reduced over the past 30 years (Munyuzangabo et al., 2020; WHO, 2011; UNDP, 2021), the rate of incidence of maternal near miss cases, which typically antecede mortality has not comparatively done so. It is a known fact that for every maternal mortality case, there happens to be 20 maternal near miss cases. However, with the reduction in maternal mortality, there should be a proportional reduction in maternal near misses, which isn't the case. Berger et al. (2013) argued that the use of shock index (SI) could be very vital in curtailing MNM. SI is a bedside assessment defined as heart rate divided by systolic blood pressure, with a normal range of 0.5 to 0.7 in healthy adults.

In the context of women who received maternal healthcare services from Fort Portal hospital, it was found that the majority of the women 230 (61.3%) had experienced a maternal near miss. The finding implies that about 6 in every 10 women who seek maternal healthcare services from Fort Portal regional referral hospital experience either severe obstetric complications or organ dysfunction or both, during pregnancy, childbirth or in the postpartum period. That also implies among every 32 women who seek antenatal, skilled birth or postpartum care from Fort portal regional referral hospital, about 20 women experience maternal near misses, 1dies and 11 do not experience any severe complications or organ dysfunction.

In other words, majority of the aforementioned category of women at the hospital experience at least a case of postpartum hemorrhage, eclampsia, sepsis, severe systemic infection, rupturing of the uterus, severe complications of abortion, cardiovascular dysfunction, respiratory dysfunction, renal dysfunction, coagulation/hematological dysfunction, hepatic dysfunction, neurological dysfunction, or uterine dysfunction. Although manageable, those indicators of MNM are in some cases fatal (Asaye, 2020; Magley & Hinson, 2020) and even if a woman does not succumb to the complications, they more often than not experience severe morbidity, some of which are of reproductive health importance. For instance, the incidence of severe postpartum hemorrhage and uterine rupture as is typical of related MNM cases is often managed with the conduction of total hysterectomies, that are not only associated with genitourinary tracts complications, and vaginal cuff dehiscence (Carugno and Fatehi, 2022) but also a halt on the reproductive potential of the victim (American College of Obstetricians and Gynecologists, 2020). Others including ischemic uterine diseases and organ dysfunctions are usual indicators for cesarean delivery (Asaye, 2020, 2020, 2020), which is in its-self associated with severe obstetric complications including placentation abnormalities, hemorrhage, and sepsis. That is in addition to the fact that cesarean section history usually predicts future birth by cesarean section, and even a higher risk of obstetric complications, not limited to a higher risk of uterine scar rupture (Hassan and Hamza, Asaye, 2020), placenta previa, coupled with limitations to how many childbirths one can have (Bolnga et al., 2017).

Of concern as well, the prevalence of maternal near miss experience among women who seek maternal healthcare from Fort portal regional referral hospital is arguably one of the highest prevalence of maternal near misses reported for any single health facility. The finding implies that the rate of MNM among women at Fort Portal hospital was 6.13 per 1000, and 0.61 per 10,000 women, which is higher than what has been reported in studies by Abdollahpour et al. (2019) (28.22%) which was multi country, Goldenberg et al. (2017) (21.3%) in Belagavi- India, Magar et al. (2020) (1.4%) in India, Mansuri and Mall (2019) in India, Koch et al. (2018) in the united states, Jayaratnam et al. (2018) (0.69%) in Australia, Ray et al. (2018) (1.7%) in Canada, Jayaratnam et al. (2016) (0.48%) in India, Tanimia et al. (2016) (0.91%) in Australia, De Lima et al. (2019) (37.6%) in Brazil, Tura et al. (2019) (24.2%), Goldenberg et al. (2017) (26.6%), Tura et al. (2019; 36.6%) in Sub Saharan Africa, Yeman et al. (2020) (6.1%) in Ethiopia, Kumela et al. (2020) (4.97%) in Asaye (2020) (15.8%) in Ethiopia, Worke et al. (2019) (26.6%) in Ethiopia, Fenta et al. (2020) (23.2%) in Ethiopia, Bolnga et al. (2017) (2.54) in Papua new Guinea, Chikadaya et al. (2018) (9.2%) in Zimbabwe, Heemelaar et al. (2020) (0.8%) in Sub Saharan Africa, Iwuh et al. (2018) (0.58%) in Cape town, Sotunsa et al. (2019) in Nigeria, Etuk et al. (2019) (0.33%) in Nigeria, AdaMu et al. (2019) (0.29%) in Nigeria, Adanikin et al. (2019) (6.33%) in Nigeria, Ugwu et al. (2020) (2.6%) in Nigeria, Oppong et al. (2019) (3.4%), Mohammadi et al. (2016; 0.63%), Goldenberg et al. (2017) (8.2%), Herklots et al. (2017) (28.7%) in Zanzibar, Lilungulu et al. (2020) (4.0%) in Tanzania, (8.7%) in Tanzania, Assarag et al. (2015) (27%) in Uganda, Nakimuli et al. (2016) (27%) in Dile et al. (2015) (22.7%) in Uganda.

The difference in the findings is more of a difference in methodological approaches between the current study and most of the aforementioned studies. For instance, some of those studies were multi-country (Abdollahpour et al., 2019; Heemelaar et al., 2020; Tura, Trang et al., 2019) with the majority including countries with more specialized obstetric care providing hospitals. Such studies were therefore more likely to report lower near misses since with specialized care comes better obstetric care and less likelihood to experience severe maternal morbidity. Others were conducted in specialized hospitals (Fenta et al., 2020) with the same above mentioned implication. Some were conducted at multiple tertiary hospitals (Chikadaya et al., 2018; Oppong et al., 2019) with which comes more likelihood of some MNM cases cancelling out. The same applied to studies that were conducted at national level (Etuk et al., 2019; Lilungulu et al., 2020; Sotunsa et al., 2019). Some were conducted using the WHO near miss criteria only (Asaye, 2020; Chikadaya et al., 2018; Heemelaar et al., 2020; Jayaratnam et al., 2018) without focus on organ dysfunction as was the case in the current study. They were therefore more likely to report lower MNM prevalence without that consideration. Some were community-based studies (Nansubuga & Ayiga, 2015; Nansubuga et al., 2016), with the implication that they missed out on the assessment of a relatively large sampling frame of mothers at facility, most of whom may have experienced maternal near misses. Some of the studies focused on only eclampsia (Asaye, 2020), with the implication that they did not follow the appropriate criteria for assessing MNMs. That study only focused on a severe obstetric outcome whose global prevalence is less than 10% (Machano and Joho, 2020) and so it was likely to report a lower MNM prevalence. Relatively fewer studies have reported higher prevalence of maternal near misses, and they included that by AleMu et al. (2019) in South Sudan (94.1 per 1,000). That study was conducted in a country that has one of the highest maternal mortality rates in the world at 1150 deaths per 100,000 (Abdollahpour et al., 2019) due to inadequate access to modern obstetric care. Women in that country are therefore more likely to experience severe maternal morbidity.

It was also found that the most prevalence indicator of maternal near misses among women at Fort Portal regional referral hospital was sepsis 187(81.3%), followed by was severe complications of abortion 143(62.2%). This is inconsistent with findings by Mansuri and Mall (2019) in which eclampsia was the commonest cause, and findings by Koch et al. (2018), Assarag et al. (2015), Liyew et al. (2017), Acosta et al. (2016), Filippi et al. (2016), Acosta et al. (2016), Gedefaw et al. (2014), and Tanimia et al. (2016) in which hemorrhage was the commonest indicator of MNM. It should be noted that these findings differ from the causes of maternal mortality of which hemorrhage would be more prominent. The finding means that sepsis is the commonest cause

of severe maternal morbidity among women at Fort portal hospital, with the second implication being that there could be gaps in the management of complications including PPH, complications of abortion, and the complications of cesarean sections, all of which are risk factors of sepsis.

4.2. Distribution of MNMs among Mothers

This current study found that among the women who experienced maternal near misses, more than three quarter of them had experienced sepsis (81.3%). This makes sepsis the most prevalent indicator of maternal near misses. This is consistent with the study which found the proportion of sepsis being high among mothers in maternity (Omona, 2021b). The proportion of post-operative sepsis was higher in maternity ward than in the General Surgical ward. In this current study, the second most prevalence determinant of maternal near misses was severe complications of abortion 143(62.2%), followed by severe systemic infection 107(46.5%), and eclampsia, 105(45.7%).

4.3. The individual determinants of maternal near misses among women

The interactional model of client behavior suggests that elements of client singularity have a significant influence on the health outcomes of an individual. That assertion of the model was found to be significantly true in the context of women at Fort portal hospital. Eight individual characteristics were found to be significant determinants of maternal near miss experience among women at the hospital. The findings showed that the prevalence of MNM was higher by 47% among women who were from rural residents (aPR = 1.470 (1.358–1.591), p = 0.000), compared to those who were in rural residents. This finding consistent with findings by Abdollahpour et al. (2019), Liyew et al. (2018b), Assarag et al. (2015), Mbachu et al. (2017), Ugwu et al. (2020), Mekango et al. (2017), and Worke et al. (2019), all of whom found rural residence to be associated with a higher risk of maternal near miss incidence.The main effect that rural residence has on the incidence MNMs is moderated through the relatively longer distance from health facilities that a rural resident has to cover, the longer time of travel to a health facility, and relatively higher socio economic inequity. The longer time of travel to a health facility, typical in rural residents leads to delays in accessing care, which in the context of obstetrics cannot only increase risk of complications occurring but also exacerbate pre-existing ones. Such delays have been unsurprisingly found to predict MNMs (Benimana et al., 2018; Dessalegn et al., 2020; Yeman et al., 2020). Further still, compared to urban residents rural residents are more likely not to be formally educated, which has also been found to increase MNM risk by 2 fold (Acosta et al., 2014, 2014; Adanikin et al., 2019; Bolnga et al., 2017; Dessalegn et al., 2020; Dias et al., 2014; Kurugodiyavar et al., 2019; Liyew et al., 2017; Mekango et al., 2017; Naik et al., 2016; Victor et al., 2016).That also explains why the prevalence of MNM experience was also higher by 15% among women who were residents of Bundibugyo district (aPR = 1.457 [1.152 −1.843], p = 0.002). Bundibugyo has numerous rural communities, who are served by only one hospital and two health center IVs in the context of obstetric care, with the implication that some of the women in the district have to travel long distances to reach one. That is in addition to the fact that the Bamba and Bakonjo ethnic groups tend to use traditional birth attendance more, hence increasing their risk for severe complications that may culminate into MNM even after referral to a health facility.

The other individual characteristic that was found to be of significance was marital status, consistent with findings by Ngoma-Hazemba et al. (2019) but inconsistent with findings by Domingues et al. (2016) who found no association between marital status and MNM incidence. The findings showed that the prevalence of MNM experience was 28 times higher among women who were single (aPR = 28.436 [9.560–84.579], p = 0.007) compared to those who were cohabiting compared to those who were cohabiting. The finding is related to the limitations that come along with being single and concurrently going through the process of gestation and childbirth, both of which requires various forms of partner support. For instance, frequent attendance of antenatal care, procurement of iron-folic acid supplements and the conduction of ultrasound scans during pregnancy are all costly ventures that are most of than not made easy with spousal support. The same applies to birth preparedness that includes procurement of all necessary birth process materials. Single women, particularly those whose records were reviewed in the current study, the majority of whom were not employed (Table 1) most likely had no spousal and hence financial support during their pregnancy and most likely found it challenging to fulfill the afore-mentioned modalities of pregnancy and birth preparedness. That may have affected their attendance of

antenatal care, and most likely caused the second delay (delay to reach health facility), which has been found to be an independent predictor of maternal morbidity and mortality (Asaye, 2020, 2020; Kapito et al. 2021; Mgawadere et al., 2017). Secondly, it has been established that among married or cohabiting pregnant women, the risk of antepartum depression is very minimal (Mehran et al., 2020). That makes women with partners less likely to obstetric complications during pregnancy), some of which are MNM indicators and less likely to delivery via cesarean section. Further still, married or cohabiting women, contrary to single ones are more likely to be beneficiaries of timely decisions to seek skilled birth attendance give the spousal support they receive. That therefore makes women in relationships to be less likely to experience the first delay, which in some settings has been found to increase risk of MNM (Benimana et al., 2018, 2018; Dessalegn et al., 2020, 2020; Yeman et al., 2020).

The finding that the prevalence of MNM incidence was higher by 41% among women who had delivered at Fort Portal hospital (aPR = 0.502 [0.014–0.194], p = 0.000) was anything but surprising. That is because the effect of skilled birth attendance on maternal morbidity and mortality reduction is well documented (Dahie, 2022). Delivery in a health facility guarantees that a woman received not only modern but prompt obstetric and emergency obstetric care, hence preventing the incidence of intrapartum complications, some of which are predictors of maternal mortality or severe maternal morbidity. Even in the event of incidence of intrapartum complications, skilled birth attendance ensures that such complications are managed in a timely manner, hence guaranteeing better prognosis and a lower risk of experiencing a maternal near miss. Such benefits of skilled birth attendance may be even more significantly pronounced when it is sought from a regional referral hospital such as Fort portal hospital which by service level is equipped with more special lied staff and equipment. It should also be noted that by the time one delivers a pregnancy with skilled birth attendance, they most likely attended antenatal care (Atuhaire et al., 2020), which has been established as being related to a lower risk of MNM incidence in many studies (Dessalegn et al., 2020; Dile et al., 2015; Domingues et al., 2016; Fenta et al., 2020; Kumela et al., 2020; Liyew et al., 2018b; Tura, Trang et al., 2019; Woldeyes et al., 2018; Worke et al., 2019; Yeman et al., 2020).

The prevalence of Maternal Near misses was 5 times higher among women who had been referred from other facilities (aPR = 5.431 [2.777–10.622], p = 0.000). This finding has a number of implications, one of which is that women who are usually referred to Fort Portal regional referral hospital from other facilities are usually referred when in a very critical stage following management attempts at lower level health facilities. It is also highly probable that when the referral process is instituted, transportation challenges emerge. Lower level health facilities may not be having readily available ambulances to make prompt referrals to Fort Portal hospital, which is symbolic of the second delay, that as earlier mentioned, is associated with a higher risk of severe morbidity and mortality as it allows for any complication to progress to severity as one tries to get to a health facility. Thirdly, it is also possible that once a referral case is received at Fort Portal regional referral hospital, emergency obstetric services are either not promptly provided or are poorly provided to the extent that women referred are not effectively resuscitated. That leaves them at a high risk of poor prognosis of any complications they are referred with, hence making them more likely to experience organ dysfunction or succumb to any incident obstetric complications

4.4. Obstetric determinants of maternal near misses among women

Consistent with findings by Fenta et al. (2020), Dessalegn et al. (2020), and Galvão et al. (2014), Kasahun and Wako (2018), Maswime and Buchmann (2017), Kongwattanakul et al. (2020), Benimana et al. (2018), and Mekango et al. (2017) and Kasahun and Wako (2018) this study found an association between cesarean sections and MNM incidence. The study however found that MNM incidence was less by 51% among women who had had a previous cesarean delivery (aPR = 0.488, CI = 0.291–.819], P = 0.007) compared to those who had not. Whereas cesarean sections are known to be associated with a higher risk of obstetric complications the effect of having history of cesarean delivery was most likely moderated by other factors, among women at Fort Portal hospital. Having history of cesarean delivery, usually predicts future elective cesarean sections, while having no such history predicts emergency cesarean sections in case of any indication. Therefore, it is highly likely that women who had no cesarean section

history but had indications for cesarean birth in their most recent pregnancy (Table 5) were most likely delivered via emergency cesarean section, which compared to elective ones among those with history, are associated with higher risk of obstetric complications (Darnal & Dangal, 2020; Benzouina et al., 2016). It thus happens that having history of cesarean delivery reduced of near misses via the abovementioned pathway. The effect of cesarean delivery history is most likely related to the finding that gravida one women had an MNM prevalence rate that was higher by 99% (aPR = 1.989 [1.420–2.787], p = 0.000). By primigravid, one has certainly not had any child birth before and hence no history of cesarean delivery. Therefore, in case of any intrapartum complication that is indicative of cesarean section, for instance, obstructed labor (Table 5), then emergency cesareans become inevitable. Given the known obstetric risks associated with emergency cesarean sections, some of which are MNM indications, primigravid women stand to be at risk of MNM.

However, it was found that Near miss prevalence was higher by 10% among women who had had two cesarean deliveries (aPR = 1.105 [1.110–1.282] p = 0.001), consistent with findings by Domingues et al. (2016). The difference between this finding and the one above is that whereas the one above deals with mere history of cesarean delivery, the current finding deals with frequency of cesarean deliveries. Even if elective cesarean sections are relatively safer than emergency ones, their numerous conduction can predispose one to immediate complications including postpartum hemorrhage, and sepsis, both of which are indicators MNM as recognized in the WHO disease specific criteria. A higher risk has been observed with numerous emergency cesarean sections (Darnal & Dangal, 2020), although multiple cesarean sections in general are associated with high morbidity. Women multiple cesarean sections have been found to have a 10-fold increased risk of placenta previa 27-fold increased risk of placenta accreta, and an 11-fold increased risk of uterine dehiscence or rupture (Narava et al., 2020), all of which are direct indicators of MNM or risk factors of its indications. (aPR = 1.387 [1.286–1.496], p = 0.000) (Ayele, et al. (2014)) compared to those who had an elective one. Severe hemorrhage could also lead to MNM (Oğlak et al., 2022).

The findings also showed that women who had their labor induced had 15 times higher prevalence of MNM (aPR = 5.676 [3.708–66.272], p = 0.000). This finding is related to the complications associated with labor induction. Labor induction has been frequently associated with emergency cesarean sections (Bo et al., 2020; Lueth et al., 2020), which are associated with complications not limited to postpartum hemorrhage, placental complications and sepsis, all of which are MNM indications. In addition, labor induction is associated with precipitated labor, placental abruptions, uterine ruptures, and hence maternal death Lueth et al., 2020). It is possible that the majority of the women who were in labor for less than 5 hours are those who were induced and/or those who had emergency cesarean sections done. That is why women who had been in labor for less than 5 hours had 7 times the risk of maternal near miss incidence (aPR = 7.219 [4.365–11.938], P = 0.000).

5. Conclusion

The prevalence of MNM among women at Fort portal hospital is substantially high; up to 6 in 10 of them experience MNMs with the most common cause being sepsis. Both individual and obstetric characteristics determine the incidence of maternal near misses, with each being of similar importance. The individual characteristics that determine maternal near miss incidence are five in number and they include type of residence, delivery at Fort Portal hospital, being referred to Fort portal hospital, referral from other facilities, and marital status. The obstetric characteristics that determined incidence of maternal near misses among women at Fort Portal regional referral hospital include; previous cesarean delivery, number of previous cesarean deliveries, duration of labor, labor induction, and gravidity

6. Strengths and limitations

This study had a number of strengths, one of which arises from the design that was used. The choice of a retrospective study design ensured that the study was not affected by recall bias which could have happened if women were to be engaged in interviews. Therefore, the findings are highly valid. Secondly, the study had rigorous eligibility criteria for inclusion, which allowed for the inclusion of only women who had received antenatal care and skilled birth attendance from the

hospital, and exclusion of those who were referred for the management of postpartum complications only. Such considerations ensured that the findings obtained on the incidence of MNM were entirely reflective of the health facility under study (Fort Portal regional referral hospital) since it is during the pregnancy and intra-partum periods that MNM happen.

Although the conduction of a retrospective chart review was of an advantage in this study, it was limited in the sense that many potentially eligible files were excluded because of incomplete information. We excluded up to 78 files. This could have significantly affected the validity of the study findings.

7. Recommendations

We now recommend as follows;

(1) Regular clinical audit and feedback about maternal near-miss and severe maternal outcomes should be made

(2) Engagement of opinion leaders and early adopters should be initiated at the facility

(3) Prospective case identification of severe maternal outcomes should be made

(4) Reminders and educational activities about maternal near-misses should be done periodically, probable quarterly

(5) Use of evidence-based checklists should be use to assess maternal near-misses and severe maternal outcomes in the health facility

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Dr Omona Kizito made the contributions related to formal analysis, data curation, investigation, supervision, validation (revising it critically for intellectual content), manuscript writing – Original Draft Preparation as well as the final approval of the version to be published.
Ms Babirye Dorothy made contributions related to conceptualization, formal analysis, investigation and methodology design and approval for publication.

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Data sharing statement
The data supporting the findings of this study are openly available in Mendeley data repository at http://doi.org/10.17632/rbwm7f8pgz.1 (Omona & Babirye, 2022).

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Appendix: DATA ABSTRACTION FORM

PART A: Socio demographic characteristics

S. No	Variables	Entry in patient record
01	Age	(1) Between 15 and 25 years ☐ (2) Between 26 and 36 years ☐ (3) Between 37 and 47 years ☐ (4) More than 47 years ☐
02	Religion	(1) Catholic ☐ (2) Muslim ☐ (3) Anglican ☐ (4) SDA ☐ (5) Born again ☐ (6) Other…… ☐
03	Marital status	(1) Married ☐ (2) Single ☐ (3) Cohabiting ☐
04	Received formal education	(1) Yes ☐ (2) No ☐
05	Level of education received	(1) Primary ☐ (2) Secondary ☐ (3) Post-secondary ☐
06	Employment status	(1) Employed ☐ (2) Not employed ☐
07	District of residence	(1) Kabarole ☐ (2) Bunyangabu ☐ (3) Kasese ☐ (4) Ntoroko ☐ (5) Bundibugyo ☐ (6) Kyenjojo ☐ (7) Kamwenge ☐

PART B: Maternal Near Miss Assessment - Severe Maternal Complication Assessment

S. No	Variables	Entry in patient record
08	Postpartum hemorrhage	(1) Experienced (between 500ml and 1000 ml) ☐ (2) Experienced (More than 1000 ml) ☐ (3) Not experienced ☐
09	Severe pre-eclampsia	(1) Experienced ☐ (2) Not experienced ☐
10	Eclampsia	(1) Experienced ☐ (2) Not experienced ☐
11	Sepsis	(1) Experienced ☐ (2) Not experienced ☐
12	Severe systemic infection	(1) Experienced ☐ (2) Not experienced ☐
13	Ruptured uterus	(1) Experienced ☐ (2) Not experienced ☐
14	Severe complications of abortion	(1) Experienced ☐ (2) Not experienced ☐

MNM Assessment - Organ Dysfunction Assessment

S. No	Variables	Marker of organ dysfunction entered I record
15	Cardiovascular dysfunction	(1) Shock ☐ (2) Cardiac arrest (absence of pulse/heart beat and loss of consciousness) ☐ (3) Use of continuous vasoactive drugs ☐ (4) Cardiopulmonary resuscitation ☐ (5) Severe hypoperfusion (lactate>5 mmol/l or > 45 mg/dl) ☐ (6) Severe acidosis (ph <7.1) ☐ (7) Not experienced ☐

(*Continued*)

S. No	Variables	Marker of organ dysfunction entered I record
16	Respiratory dysfunction	(1) Acute cyanosis ☐ (2) Gasping ☐ (3) Severe tachypnea (respiratory rate >40 breaths per minute) ☐ (4) Severe bradypnea (respiratory rate <6 breaths per minute) ☐ (5) Intubation and ventilation not related to anaesthesia ☐ (6) Severe hypoxemia (O_2 saturation <90% for ≥60 min or PAO_2/fio2 <200) ☐ (7) Not experienced ☐
17	Renal dysfunction	(1) Oliguria non-responsive to fluids or diuretics ☐ (2) Dialysis for acute renal failure ☐ (3) Severe acute azotemia (creatinine ≥300 µmol/ml or ≥3.5 mg/dl) ☐ (4) Not experienced ☐
18	Coagulation/haematological dysfunction	(1) Failure to form clots2. Massive transfusion of blood or red cells (≥5 units) ☐ (2) Severe acute thrombocytopenia (<50 000 platelets/ml) ☐ (3) Not experienced ☐
19	Hepatic dysfunction	(1) Jaundice in the presence of pre-eclampsia ☐ (2) Severe acute hyperbilirubinemia (bilirubin >100 µmol/l or >6.0 mg/dl) ☐ (3) Not experienced ☐
20	Neurological dysfunction	(1) Prolonged unconsciousness (lasting ≥12 h)/coma (including metabolic coma) ☐ (2) Stroke ☐ (3) Uncontrollable fits/status epilepticus ☐ (4) Total paralysis ☐ (5) Not experienced ☐
21	Uterine dysfunction	(1) Uterine haemorrhage or infection leading to hysterectomy ☐ (2) Not experienced ☐

PART C: MNM Assessment - Other Individual Characteristics

S. No	Variables	Entry in patient record
21	Residence type	(1) Rural ☐ (2) Urban ☐
22	Attended Antenatal care during pregnancy	(1) Yes ☐ (2) No ☐
23	Frequency of ANC attendance	(1) One visit ☐ (2) Two visits ☐ (3) Three visits ☐ (4) Four visits ☐ (5) More than four visits ☐
24	Trimester of Initiation of ANC	(1) First trimester ☐ (2) Second trimester ☐ (3) Third trimester ☐
25	Delivered pregnancy in health facility	(1) Yes ☐ (2) No ☐
	Delivered pregnancy at Fort Portal hospital	(1) Yes ☐ (2) No ☐
24	Length of hospital stay	(1) More than 7 days ☐ (2) Less than 7 days ☐
25	Referred from other facilities	(1) Yes ☐ (2) No ☐

PART D: MNM Assessment - Obstetric Characteristics

S. No	Variables	Entry in patient record
26	Nature of pregnancy	(1) Multiple ☐ (2) Singleton ☐
27	Previous cesarean delivery	(1) Yes ☐ (2) No ☐
28	Number of cesarean deliveries	(1) One ☐ (2) Two ☐ (3) Three ☐
29	Type of most recent cesarean delivery	(1) Emergency ☐ (2) Elective ☐
28	Recent mode of delivery	(1) SVD ☐ (2) Cesarean birth ☐
29	Duration of labor	(1) Less than 5 hours ☐ (2) More than 5 hours ☐
30	Labor induced	(1) Yes ☐ (2) No ☐
31	Labor obstructed	(1) Yes ☐ (2) No ☐
32	Gravidity	(1) One ☐ (2) Two ☐ (3) Three ☐ (4) More than three ☐
33	Still birth history	(1) Yes ☐ (2) No ☐
34	Parity	(1) Yes ☐ (2) No ☐
35	Outcomes of pregnancy	(1) Spontaneous abortion ☐ (2) Induced abortion ☐ (3) Live birth ☐ (4) Still birth ☐

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