Determinants of uterine rupture at public hospitals of western Ethiopia: A case–control study

Oliyad Tesema[1], Temesgen Tilahun[2] and Gemechu Kejela[3] (iD)

Abstract

Introduction: Uterine rupture is a separation of the entire thickness of the uterine wall with the extrusion of fetal parts to the peritoneal cavity. It contributes to high maternal and perinatal mortality in Ethiopia. This study was aimed to identify determinants of uterine rupture among mothers who gave birth at East Wollega Zone public hospitals.

Methods: A facility-based unmatched case–control study was conducted among 239 samples (47 cases and 192 controls) from 5 June 2019 to 30 September 2019. Cases were those with uterine rupture, and controls were those free from uterine rupture. Cases were selected consecutively, and controls were selected using a systematic sampling method. For analysis, data were entered into Epi-data version 3.1 and exported to SPSS version 20. Descriptive statistics were performed to describe the variables. Binary and multivariable logistic regression were used in the analysis. The outputs were presented using an adjusted odds ratio with 95% confidence intervals.

Results: Two hundred thirty-nine (47 cases and 192 controls) mothers who gave birth in public hospitals in the East Wollega zone were interviewed, making a response rate of 100%. Living in an urban area (adjusted odds ratio = 0.219, 95% confidence interval: 0.067, 0.717), prolonged labor (adjusted odds ratio = 5.401, 95% confidence interval: 1.825, 15.981), obstructed labor (adjusted odds ratio = 4.333, 95% confidence interval: 1.276, 14.715), previous history of C/S (adjusted odds ratio = 6.5261, 95% confidence interval: 1.889, 22.554), and having no history of female genital cutting (adjusted odds ratio = 0.190, 95% confidence interval: 0.053, 0.682) were predictors of uterine rupture.

Conclusion: In this study, socio-demographic, maternal nutrition, obstetric, and health system-related factors were identified as risks of uterine rupture. Particular emphasis should be given to modifiable risk factors to reduce maternal morbidity and mortality in the study area.

Introduction

Uterine rupture is the spontaneous tearing of the uterus that may result in the fetus being expelled into the peritoneal cavity.[1] A complete uterine rupture is the complete disruption of all uterine layers, including the serosa. This rupture occurs when both the myometrium and peritoneum wall are ruptured. Uterine dehiscence, or incomplete uterine rupture, is a uterine scar separation where the serosa and peritoneum are intact with the myometrium wall breached.[2]

Uterine rupture is a catastrophic obstetric complication that is associated with high maternal morbidity and mortality.[3–5] It is one of the top four causes of maternal mortality, accounting for approximately 36% of all maternal deaths.[6]

In Ethiopia, a systemic review conducted on 16 studies, including a total of 91,784 women, indicated that the prevalence of uterine rupture ranged from 8–262.[7] The rupture,

[1]Department of Nursing, Nekemte College of Health Science, Nekemte, Ethiopia
[2]School of Medicine, Institute of Health Sciences, Wollega University, Nekemte, Ethiopia
[3]Department of Public Health, Institute of Health Sciences, Wollega University, Nekemte, Ethiopia

Corresponding author:
Gemechu Kejela, Department of Public Health, Institute of Health Sciences, Wollega University, Nekemte 395, Ethiopia.
Email: gemechukejela86@gmail.com

which occurs from an unknown, previously scarred uterus, has a sudden onset and can be associated with severe consequences for maternal and fetal outcomes.[8] It can result in serious complications such as hemorrhagic shock, which can lead to a lack of oxygen for the fetus, permanent brain injury due to hypoxia, and even death. The rupture of an unscarred uterus is unexpected, and because of this, the diagnosis may therefore be delayed.[9]

Uterine rupture during pregnancy and childbirth is one of the most direct causes of the most destructive complications of labor that expose the mother and fetus to complications. The signs and symptoms of uterine rupture include sudden cessation of uterine contractions, which is followed by abdominal pain and vaginal bleeding. Physical findings among patients with uterine rupture include absent fetal heartbeat followed by an easily palpable fetal part and shock, which leads to severe anemia.[10,11]

Factors associated with uterine rupture include labor management-related factors, maternal nutritional status, maternal height, a maternal medical condition during the current pregnancy, health service-related factors, and gynecologic and obstetric-related factors.[12–15] Another study identified harmful traditional practices and delay-related factors as contributing factors to uterine rupture.[10,16] In Dessie Hospital in Ethiopia, rural residence, lack of antenatal care (ANC) visits, and grand multipara are the frequent risk factors of uterine rupture.[16] Obstructed labor is one of the leading underlying causes of uterine rupture in the Amhara region of Ethiopia.[14] From a review of the existing evidence, determinants of uterine rupture among mothers who give birth in Ethiopian health facilities have not been well identified and documented as the determinants differ from place to place.[13] Also, there has never been a study conducted before in the current study area. Therefore, this study was aimed at identifying determinants of uterine rupture among mothers who gave birth in East Wollega zone public hospitals. The result of the study will provide policymakers, program managers, and decision-makers with relevant information on the determinants of uterine rupture in the study area. It will also serve as a baseline for further studies.

Methods

Study design, setting and population

An institution-based unmatched case–control study was conducted among 239 (47 cases and 192 controls) in East Wollega zone public hospitals from 5 June 2019 to 30 September 2019. The East Wollega zone is one of the Oromia zones found in the western parts of Ethiopia. The East Wollega zone has a total population of 1,575,204 (males, 786,967 and females, 788,237) with women of the reproductive age group of 146,612. There are 64 health centers (63 governmental health centers and 1 nongovernmental health center), 326 health posts, 207 private clinics, 45 drug stores, 5 nongovernmental organization clinics, 14 rural drug vendors, and five

hospitals (Wollega University Referral Hospital, Nekemte Specialized Hospital, Gida General Hospital, Sire District Hospital, and Arjo District Hospital).

All women who gave birth in public hospitals in the East Wollega zone and were eligible during data collection time were included. Cases were all women who had a uterine rupture with a separation of the entire thickness of the uterine wall, extrusion of fetal parts into the peritoneal cavity, and uterine muscle disruption.[9] Controls were all women who gave birth by any mode of delivery and who had not suffered from a uterine rupture.

Inclusion and exclusion criteria

Mothers who gave birth in public hospitals in the East Wollega zone between 5 June and 30 September 2019, and were diagnosed with uterine rupture after 28 weeks of gestational age, as well as those who were referred with uterine rupture from other health facilities, were included in the case group, while those who gave birth but did not develop uterine rupture during the same period, were included in the control group.

Cases of ruptured uterus that occurred following vehicle accidents were excluded from the study.

Sample size and sampling technique

Using Epi-info version 7, the Double population proportion formula was used to calculate sample size based on the following assumptions: power of the study = 80%, case–to–control ratio = 1–4, confidence level = 95%, percentage of controls exposed to risk factor (Mal-presentation among controls) = 5.34%, percentage of cases exposed (Mal-presentation among cases) = 21.09%,[17] and adding 5% non-response rate, the final sample size becomes 239 (47 cases and 192 controls).

All hospitals in the East Wollega zone (Nekemte Specialized Hospital, Wollega University Referral Hospital, Gida General Hospital, Arjo District Hospital, and Sire District Hospital) were included in the study. Then, a proportional allocation for the included hospitals was made based on the number of deliveries that the respective hospital conducted in the same month in the year before the study period. Finally, cases were selected consecutively and four controls for each case were selected by a systematic sampling method.

Outcome

In this study, uterine rupture is defined as the separation of the entire thickness of the uterine wall with extrusion of fetal parts into the peritoneal cavity and disruption of the uterine muscle and serosa during pregnancy or childbirth after 28 weeks of gestational age.

Covariates and exposure variables

Obstructed labor was diagnosed when a laboring mother presented with >24 h of labor, unable to support herself or

unable to move her lower extremities, with deranged vital signs, distended bladder, Bandl's ring formed in the lower uterine segment, fetal distress or death, edematous vulva, big caput, significant mold, and foul-smelling and thick meconium-stained amniotic fluid.[18]

Prolonged labor, also known as failure to progress, is defined as labor that lasts for more than or equal to 18 h.

Mid-upper arm circumference (MUAC) was measured in the right arm at the level midway between acromion and olecranon processes in centimeters to the nearest decimal place. Finally, women were classified as undernourished for those whose MUAC was less than 23 cm and not for those whose MUAC was greater than or equal to 23 cm.[19]

In this study, body mass index (BMI) was calculated by taking a pregnant woman's weight in kg divided by her height in meters squared and classified as undernourished for those whose BMI was less than 19.5kg/m^2 or not for those whose BMI was greater than or equal to 19.5kg/m^2.[19]

The inter-pregnancy interval was defined as the duration of the month between the previous pregnancy and the current pregnancy. It is optimum when the interval is greater than or equal to 24 months and short for those with less than 24 months. Instrumental delivery is defined as the delivery of the fetus using instruments (forceps or vacuum).

Cephalo-pelvic disproportionation (CPD) is defined as a disparity between the fetal head and the maternal pelvis, usually in the absence of fetal or maternal jeopardy.[20]

Birth weight is defined as the first weight of the baby, taken just after he or she is born. In this study, the newborn is classified as "big" if his or her birth weight is greater than or equal to 4000 g, and not for those who had a birth weight of less than 4000 g.

Data collection tools and procedures

The structured interviewer-administered questionnaire was prepared in English by reviewing related literatures[7,10,17,21–25] and translated into a regional language (Afan Oromo) and then translated back to English by a bilingual expert to check its consistency. The questionnaire has five parts: socio-demographic-related factors, nutritional status of the mother, obstetrical factors, gynecologic factors, and health system and delay-related factors. Two reviewers (one public health expert and one person who was trained in questionnaire construction) validated the final questionnaire. Also, a structured checklist was used to collect data from the delivery summary, delivery registers, medical charts of all women, operating theater registers, admission history, labor follow-up sheet, operation notes, and ANC follow-up sheet. In addition, the anthropometric indicators, including maternal weight in kg and maternal height in cm, to calculate maternal BMI and MUAC in cm, were taken during data collection. The data was collected by five clinical nurses and supervised by two public health professionals.

Data quality assurance

To ensure the quality of data, a range of mechanisms were employed to address major areas of bias introduction during the data collection process. First, data collectors were trained on how to gather the appropriate information, data collection techniques, and the whole contents and subject matter of the questionnaire. A week before the actual data collection, the questionnaire was pre-tested on 5% (12 mothers, 2 cases, and 10 controls) of the sample among mothers who gave birth at Gimbi General Hospital (out of the study hospitals) and, depending on the findings, the orders of questionnaires were arranged and some questions were added on to the previously prepared one. At the end of each data collection day, the questionnaire was reviewed and cross-checked for completeness, accuracy, and consistency by the supervisors, and a corrective discussion was undertaken with all the data collectors.

Statistical analysis

The information was coded, checked, and cleared before being entered into Epi-data version 3.1 software and exported to SPSS version 20 for analysis. Descriptive statistics such as the mean and standard deviation were computed. Tables and charts were used for data presentation. Initially, a bivariable analysis was performed between each of the potential factors associated with the case and the control group. Then, variables with a p value of 0.25 were taken to multivariable logistic regression. A backward likelihood ratio with a 0.1 probability of removal was used to develop the model. The adjusted odds ratio was estimated with 95% confidence interval (CI) to show the strength of association, and a p value of 0.05 was used to declare statistical significance. The necessary assumptions of logistic regression like the goodness of fit of the final model were checked using the Hosmer-Lemeshow test, considering good fit at p value 0.05 and the omnibus likelihood test 0.05, normality by using histogram, and the presence of multi-collinearity by using variance inflation factor (VIF).

Results

Socio-demographic characteristics

From the calculated sample size of 239 (47 cases and 192 controls), all responded, making a response rate of 100%. The mean age and standard deviation (SD) for the cases and controls were 31.06 (SD: 5.35) and 27.49 (SD: 4.55), respectively. From all the study participants, 25 (53.2%) of cases and 18 (9.4%) of controls were greater than or equal to 35 years old. Concerning the marital status, in all of the cases, 47 (100%) and 182 (94.8%) of the controls were married, 5 controls were single, and 3 controls were widowed. Above four-fifths, 40 (85.1%) of cases were rural residents, but only 92 (47.9%) of controls were from a rural area.

Table 1. Socio-demographic characteristic of study participant at East Wollega zone public hospitals, Ethiopia, 2019.

Variable	Category	Cases (n = 47)	Controls (n = 192)	p value
Age in years	≤24 years	11 (23.4%)	56 (29.2%)	0.001
	25–34 years	11 (23.4%)	118 (61.5%)	
	≥35 years	25 (53.2%)	18 (9.4%)	
Residence	Urban	5 (10.6%)	100 (52.1 %)	<0.001
	Rural	42 (89.4%)	92 (47.9 %)	
Educational status of the respondents	Cannot read and write	19 (40.4%)	22 (11.5%)	<0.001
	Can read and /or write	14 (29.8%)	44 (22.9%)	
	Primary level (1–8)	5 (10.6%)	43 (22.4%)	
	Secondary level (9–12)	5 (10.6%)	36 (18.8%)	
	Diploma/certificate	4 (8.5%)	24 (12.5%)	
	Degree and above	0 (0.0%)	23 (12.0%)	
Occupational	Employed	9 (19.10%)	42 (21.9%)	0.683
	Unemployed	38 (80.90%)	150 (78.1%)	
Average household monthly income level	<1596.00 ETB	36 (76.6%)	105 (54.7%)	0.001
	>1596.00ETB	11 (23.4%)	87 (45.3%)	
Distance from health facility	Within 10 km	28 (59.6%)	144 (75.0 %)	0.035
	Above 10 km	19 (40.4 %)	48 (25.0 %)	

Farmers accounted for the highest percentage of study participants (17 (36.2%) of cases and 50 (26%) of controls). Regarding the educational status of study participants, 19 (40.4%) of cases and 22 (17.5%) of controls cannot read and write; 14 (29.8%) of cases and 44 (22.9%) of controls can read and write but have no formal education (Table 1).

Nutritional status of the mother

Respondents in the case group had higher odds of having a mid-upper arm circumference (MUAC) of 23 cm compared to respondents in the control group (38 (80.90%) among cases versus 9 (19.10% among controls)) (p=0.002) (Figure 1).

Regarding the body mass index (BMI), there was no statistically significant difference between the case and control groups. Nineteen (40.40%) of cases and 106 (55.20%) of controls were below 19.5 kg/m^2 (p=0.069) (Figure 2).

Obstetrics and gynecologic characteristics

In terms of obstetric-related factors, 41 (87.2%) of cases and 185 (96.4%) of controls received ANC follow-up. From those who had ANC follow-up, 21 (51.2%) of cases and 34 (18.4%) of controls had followed a maximum of two ANC visits. On the other hand, 20 (48.8%) of cases and 151 (81.1%) of controls had followed an ANC visit more than twice during their current pregnancy. Labor management was applied to 20 (42.6%) of cases and 95 (49.5%) of controls. Out of those to whom labor management was applied, 11 (55.0%) of cases and 42 (44.2%) of controls were induced, 7 (35.1%) of cases and 46 (48.4%) of controls were augmented, and fundal pressure was applied to 2 of the cases and 7 of the controls. High proportion 37 (78.7%) of cases gave big babies compared to
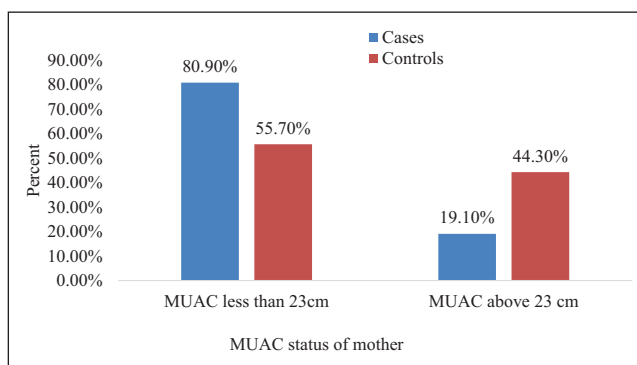
Figure 1. MUAC status of mothers who gave birth at East Wollega zone public hospitals, 2019.

controls of 77 (40.1%) (p=0.001). Nearly one-tenth (12.5%) of the cases and 24 (12.5%) of controls were diagnosed with mal-presentation/malposition. Seven (14.9%) of cases and 17 (8.9%) of controls had abnormal placenta attachment (morbidly adherent placenta), 10 (21.3%) of cases and 16 (8.3%) of controls had failed induction, 5 (10.6%) of cases and 18 (9.4%) of controls had CPD. Eight (17.0%) cases and 13 (6.8%) of controls were diagnosed with high blood pressure (>120/80 mm Hg), and 7 (14.9%) of cases and 21 (10.9%) of controls were diagnosed with shock during labor and delivery. A high proportion of 14 (29.8%) of cases had a previous history of uterine surgery compared to 21 (10.9%) of controls (p=0.001) (Table 2).

Concerning the previous mode of delivery, 14 (37.8%) of cases gave birth by Cesarean section (CS), whereas 86 (67.7%) of controls gave birth by spontaneous vaginal delivery (Figure 3).
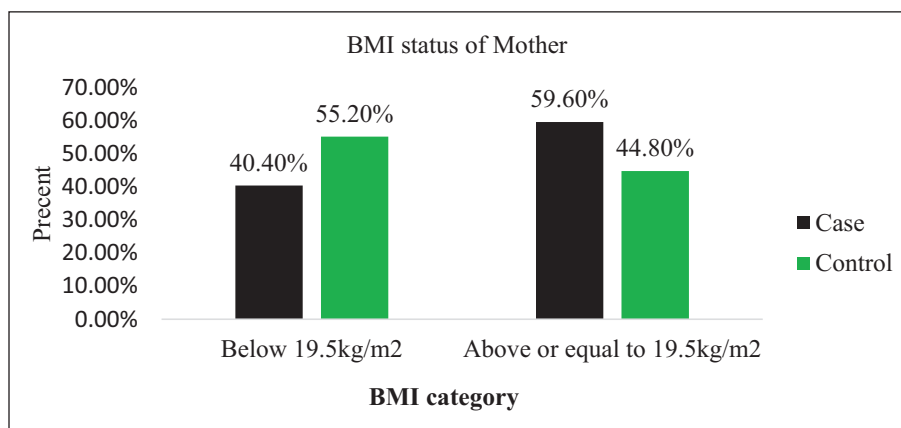
Figure 2. BMI status of mothers who gave birth at East Wollega zone public hospitals, 2019.

Table 2. Obstetric characteristics of study participant who gave birth in east Wollega zone public hospitals, Ethiopia, 2019.

Variable	Category	Cases (n = 47)	Controls (n = 192)	p value
Gestational age	28–38 weeks	18 (38.3%)	86 (44.8%)	0.421
	Above 38 weeks	29 (61.7%)	106 (55.2%)	
Parity of mother (n = 37, n = 127)	Prim para	10 (21.3%)	65 (33.9%)	<0.001
	Multipara	23 (48.9%)	115 (59.9%)	
	Grand multipara	14 (29.8%)	12 (6.2%)	
Pregnancy interval (n = 37, n = 127)	<24 month	31 (66.0%)	75 (39.1%)	0.001
	≥24 month	16 (34.0%)	117 (60.9%)	
Followed by Partograph	Yes	18 (38.3%)	167 (87.0%)	0.001
	No	29 (61.7%)	25 (13.0%)	
Current Duration of labor	<18 h	23 (48.9%)	163 (84.9%)	<0.001
	≥18 h	24 (51.1%)	29 (15.1%)	
Current newborn birth weight	<4000 g	10 (21.3%)	115 (59.9%)	0.001
	≥4000 g	37 (78.7%)	77 (40.1%)	
Does the mother was diagnosed for having obstructed labor	Yes	17 (36.2%)	18 (9.4%)	0.001
	No	30 (63.8%)	174 (90.6%)	
Current destructive delivery	Yes	6 (12.8%)	8 (4.2%)	0.024
	No	41 (87.2%)	184 (95.8%)	
History of previous C/S	Yes	14 (29.8%)	20 (10.4%)	0.001
	No	33 (70.2%)	172 (89.6%)	

Regarding the previous place of delivery, the majority of mothers (14, or 37.8%) of cases and (53, or 41.7%) of controls gave birth at the health center (Figure 4).

Harmful traditional practice related factors

Harmful traditional practices like female genital cutting (FGC) were practiced more frequently among cases than controls (38 (80.9%) among cases vs 121 (63.0%) among controls) (p = 0.020) (Figure 5).

Health system related factors and delays

From all of the study participants, more than half (53.2%) of cases and 72 (37.5%) of controls faced infrastructure proble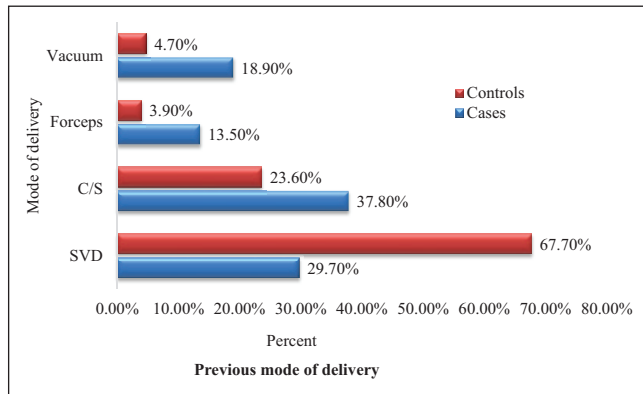ms such as electricity, water, medication, and the road to using health facilities. Sixteen (64.0%) of cases and 32 (44.4%) of controls had no road to use for health services. A high proportion, 14 (29.8%) of cases compared to 28 (14.6%) of controls, did not get service immediately when they reached the health facility (p = 0.014). Lack of electric power was the major reason for not getting health service as soon as they reached the health facility in 6 (42.9%) of cases and 11 (37.9%) of controls. A high proportion, 174 (90.6%) of controls compared to 28 (59.6%), of cases were followed by skilled health professionals during labor for the current delivery (p 0.001) (Table 3).

Clinical findings of mothers

When fetal heartbeat (FHB) was checked on all study participants on admission, only 15 (31.1%) of cases and 183

(95.3%) of controls were positive. More than two-thirds, 32 (68.1%) of cases and 9 (4.7%) of controls FHB were negative on admission. Twenty-two (46.8%) of cases and 7

(3.6%) of controls fetal parts were palpable, and 25 (53.2%) of cases and 185 (96.4%) of control fetal parts were not palpable on admission. Similarly, 39 (83.0%) of cases and 159 (82.8%) of controls were presented with low blood pressure (120/80 mm Hg) on physical findings at admission. Regarding pulse rate, 21 (44.7%) of cases and only 9 (4.7%) of controls had a rapid pulse rate of >100 bpm.

Uterine rupture/outcome

From this study, the most frequently occurring site of uterine rupture was the anterior lower segment of uterus 18 (38.03%). There is also uterine rupture on the left lateral 9 (19.1%), right lateral 8 (17.8%), and 2 of the cases are fundal. Frequent types of uterine rupture accounted for 27 (57.4%) and 20 (42.6%) of incomplete rupture and complete rupture, respectively. Only three cases of uterine rupture have involved the bladder.

The most common presenting features of mothers at admission were cessation of contraction (42.6%) in the case group and pushing down pain (50%) in the control group

Figure 3. Previous mode of delivery among mothers who gave birth in East Wollega zone public hospitals, 2019.
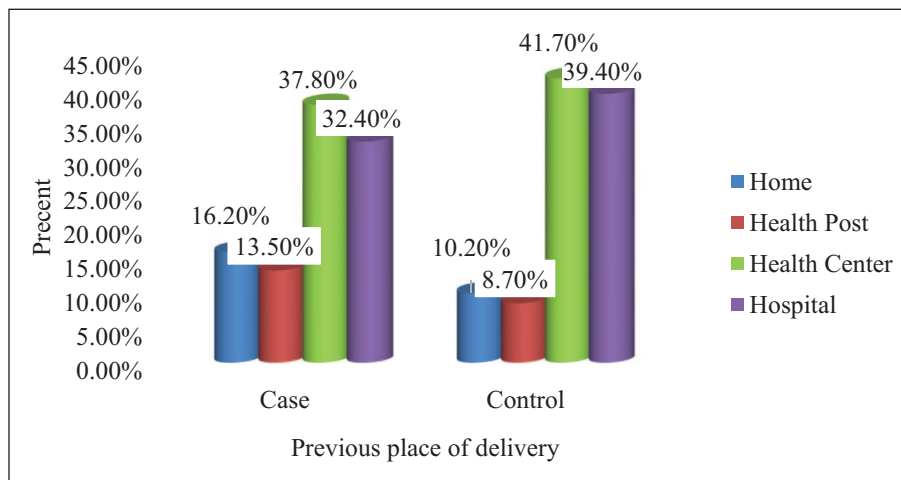

Figure 4. Previous place of delivery among mothers who gave birth in East Wollega public zone hospitals, 2019.
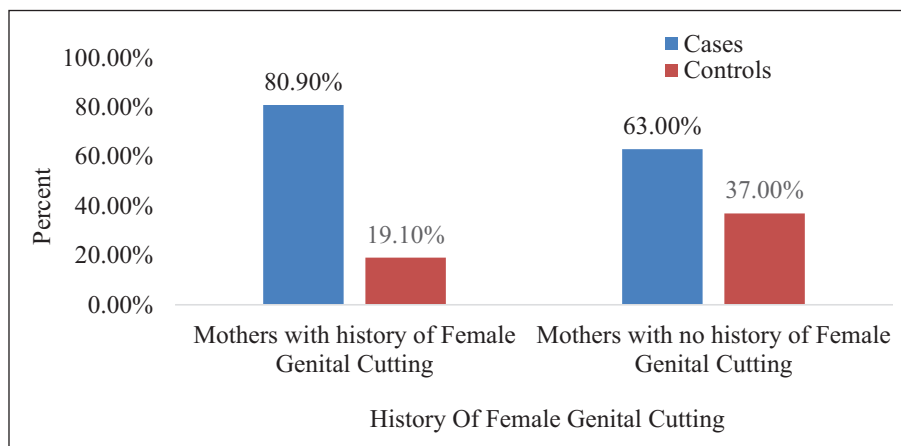
Figure 5. History of female genital cutting among mothers who gave birth in East Wollega zone public hospitals, 2019.

Table 3. Health system–related factors and delays on study participant in East Wollega zone public hospitals, Ethiopia, 2019.

| Variable	Category	Cases (n = 47)	Controls (n = 192)	p value
Knowledge of place of delivery	Yes	41 (87.2%)	178 (92.7%)	0.224
	No	6 (12.8%)	14 (7.3%)	
Where to deliver (n = 41, n = 178)	Home	11 (26.8%)	8 (4.5%)	<0.001
	Health facility	30 (73.2%)	178 (95.5%)	
Infrastructure problem	Yes	25 (53.2%)	72 (37.5%)	0.050
	No	22 (46.8%)	120 (62.5%)	
Types of infrastructure problem (n = 25, n = 72)	Road	17 (65.4%)	32 (44.4%)	0.253
	Ambulance	7 (26.9%)	29 (40.3%)	
	Health facility	1 (3.8%)	2 (2.8%)	
	Others	1 (3.8%)	9 (12.5%)	
Service delivery at health facility	Yes	33 (70.2%)	164 (85.4%)	0.014
	No	14 (29.8%)	28 (14.6%)	
Reason for not getting service (n = 33, n = 164)	Human power	2 (14.3%)	6 (20.7%)	0.227
	Medication	3 (21.4%)	11 (37.9%)	
	Water	3 (21.4%)	1 (3.4%)	
	Electric power	6 (42.9%)	11 (37.9%)	
Labor followed by health professional	Yes	28 (59.6%)	174 (90.6%)	<0.001
	No	19 (40.4%)	18 (9.4%)	
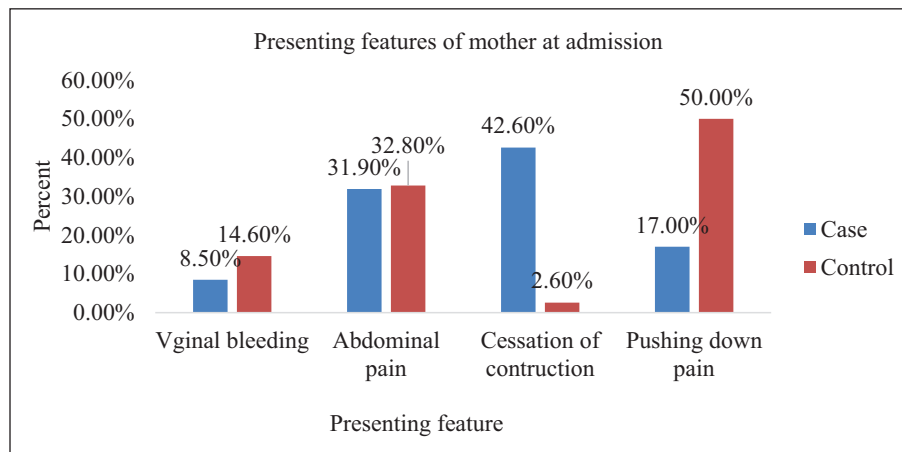
Figure 6. Presenting feature of mother at admission among mothers who gave birth in East Wollega zone public hospitals, 2019.

(Figure 6). Concerning the types of procedures done to repair a ruptured uterus, repair without bilateral tubal ligation (BTL) was the most frequent procedure done for the management of uterine rupture 22 (46.8%) (Figure 7).

Determinants of uterine rupture

In multivariable logistic regression analysis, urban residence, low MUAC status of the mother, duration of labor ⩾18 h, newborn birth weight ⩾4000 g, a mother with obstructed labor, a mother with a history of previous CS, mothers who did not follow by partograph, and mothers with a history of FGC were significantly associated with the occurrence of uterine rupture.
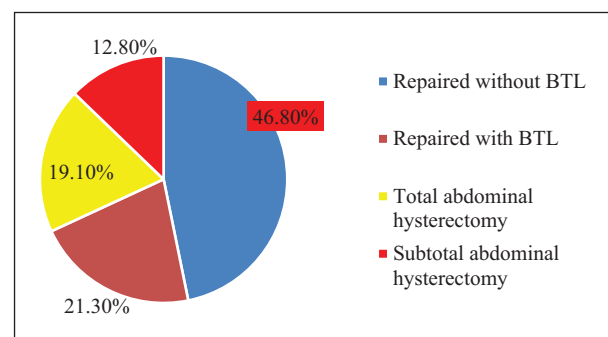
Figure 7. Types of procedure done for ruptured uterus repair among mothers who gave birth in East Wollega zone public hospitals, 2019.

Table 4. Multivariate logistic analysis of uterine rupture in east Wollega zone public hospitals, Ethiopia, 2019.

Variables	Category	Case N=47	Controls N=192	COR 95% CI; p<0.25	AOR 95% CI; p<0.05
Age of respondents	25–34 years	11 (23.4%)	118 (61.5%)	1	1
	≤24 and ≥35 years	32 (76.6%)	74 (38.5%)	5.219 (2.502, 10.885)	1.806 (0.623, 5.231)
Residence area	Urban	5 (10.6%)	121 (63.0%)	0.110 (0.042, 0.289)	**0.219 (0.067, 0.717)**
	Rural	42 (89.4%)	71 (37.0%)	1	1
Average monthly income	<1596.00ET	36 (76.6%)	105 (54.7%)	2.712 (1.303, 5.641)	1.682 (0.478, 5.917)
	≥1596.00ET	11 (23.4%)	87 (45.3%)	1	1
Distance from health facility	Within 10 km	28 (59.6%)	144 (75.0 %)	1	1
	Above 10 km	19 (40.4 %)	48 (25.0 %)	2.036 (1.044, 3.970)	0.969 (0.290, 3.242)
MUAC status	<23 cm	38 (80.9 %)	107 (55.7 %)	3.354 (1.537, 7.320)	**4.164 (1.287, 13.476)**
	≥23 cm	9 (19.1 %)	85 (44.3 %)	1	1
Pregnancy interval	<24 month	31 (83.8%)	75 (59.1%)	3.022 (1.548, 5.903)	1.756 (0.588, 5.136)
	≥24 month	6 (16.2%)	52 (40.9%)	1	1
ANC follow up	Yes	41 (87.2%)	185 (96.4%)	1	1
	No	6 (12.8%)	7 (3.6%)	3.868 (1.235, 12.114)	0.639 (0.113, 3.608)
No. of ANC follow-up	<2 visits	23 (48.9%)	36 (18.8%)	4.153 (2.110, 8.173)	2.684 (0.902, 7.985)
	≥2 visits	24 (51.1%)	156 (81.2%)	1	1
Current duration of labor	<18 h	23 (48.9%)	163 (84.9%)	1	1
	≥18 h	24 (51.1%)	39 (15.1%)	5.865 (2.927, 11.753)	**5.401 (1.825, 15.981)**
Newborn birth weight	<4000 g	10 (21.3%)	115 (59.9%)	1	1
	≥4000 g	37 (78.7%)	77 (40.1%)	5.526 (2.595, 11.767)	**5.650 (1.938, 16.469)**
Obstructed labor	Yes	19 (40.4%)	17 (8.9%)	6.985 (3.246, 15.032)	**4.070 (1.186, 13.963)**
	No	28 (59.6%)	175 (91.1%)	1	1
Destructive delivery	Yes	6 (12.8%)	8 (4.2%)	3.185 (1.143, 8.874)	1.114 (0.167, 7.145)
	No	41 (87.2%)	184 (95.8%)	1	1
Previous history of c/s	Yes	14 (29.8%)	20 (10.4%)	3.648 (1.676, 7.943)	**6.526 (1.889, 22.554)**
	No	33 (70.2%)	172 (89.6%)	1	1
Mal presentation	Yes	12 (25.5%	24 (12.5%)	2.400 (1.097, 5.250)	1.988 (0.598, 6.602)
	No	35 (74.5%)	168 (87.5%)	1	1
Failed induction	Yes	10 (21.3%)	16 (8.3%)	2.973 (1.251, 7.068)	1.224 (0.273, 5.483)
	No	37 (78.7%)	176 (91.7%)	1	1
History of FGC	Yes	38 (80.9%)	121 (63.0%)	1	1
	No	9 (19.1%)	71 (37.0%)	0.404 (0.184, 0.884)	**0.190 (0.053, 0.682)**
Followed by partograph	Yes	18 (38.3%)	167 (87.0%)	1	1
	No	29 (61.7%)	25 (13.0%)	10.762 (5.224, 22.174)	**9.416 (3.245, 27.316)**
Followed by health professional	Yes	28 (59.6%)	174 (90.6%)	1	1
	No	19 (40.4%)	18 (9.4%)	2.608 (1.024, 6.645)	0.792 (0.167, 3.751)

Adjusted for: Age, average monthly income, distance from health facilities, pregnancy interval, Antenatal care follow up, presence of destructive delivery, mal presentation, failed induction, followed by health professionals, and number of Antenatal care follow up.

In this study, being an urban resident decreases the odds of developing uterine rupture by 78.1% compared to rural residents (adjusted odds ratio (AOR)=0.219, 95% CI: 0.067, 0.717). The odds of developing uterine rupture were four times higher for mothers with MUAC measurements below 23 cm compared to their counterparts (AOR=4.164, 95% CI: 1.287, 13.476).

The odds of developing uterine rupture are 5.6 times higher for mothers who gave birth to big babies (in this study, ≥4000 g) compared to their counterparts (AOR=5.650, 95% CI: 1.938, 16.469). The odds of developing uterine rupture are 5.4 times higher for mothers who have labored for more than 18 h compared to their counterparts (AOR=5.401, 95%

CI: 1.825, 15.981). This study revealed that the odds of developing uterine rupture are four times higher for mothers who were diagnosed with obstructed labor compared to their counterparts (AOR=4.070, 95% CI: 1.186, 13.963).

The odds of developing uterine rupture were six-and-a-half times higher for mothers with previous CS compared to their counterparts (AOR=6.526, 95% CI: 1.889, 22.554). Also, having no history of female genital cutting decreased the odds of developing uterine rupture by 81% (AOR=0.190, 95% CI: 0.053, 0.682). The study also revealed that the odds of developing uterine rupture are nine times higher for mothers who did not followed by partograph compared to their counterparts (AOR=9.416, 95% CI: 3.245, 27.316) (Table 4).

Discussion

The study was aimed at identifying determinants of uterine rupture among mothers who gave birth at East Wollega Zone public hospitals. In the current study, residence, MUAC status of the mother, duration of labor, newborn birth weight, obstructed labor, history of previous CS, follow-up of labor using partograph, and history of female genital cutting were significantly associated with the occurrence of uterine rupture.

Urban residents were less likely to develop uterine ruptures than rural residents. The result is supported by the study conducted in Adama, Ethiopia,[17] the study conducted in Wolliso, Ethiopia,[6] the study conducted in Dessie, Ethiopia,[21] and the study conducted in Sultana Zanana Hospital, Gandhi Medical College.[14] The possible reason might be that women residing in urban areas have access to health facilities and access to information about institutional deliveries that make them less likely to develop uterine rupture. Also, most women in the rural area have low economic status, low access to education, are less aware of labor and delivery complications, and have low utilization of maternal health services like ANC, family planning, and emergency CS, which might directly or indirectly increase the occurrence of uterine rupture in this community.

The odd of uterine rupture among mothers with MUAC status of below 23 cm is four times higher than those with MUAC measure of greater than 23 cm. This finding is consistent with the study conducted on the determinants of a global MUAC cut-off to assess malnutrition in pregnant women in Ethiopia.[26] This may be due to poor childhood nutritional status and the fact that malnourished mothers are unable to have good contraction during delivery which can result in mothers staying with prolonged and obstructed labor. Chronically malnourished mothers have poor physical development and they can have contracted pelvis which results in uterine rupture.

In terms of labor duration, mothers who labored for 18 h were five times more likely than their counterparts to develop uterine rupture. It is supported by the study conducted at Amhara regional referral hospitals, Ethiopia,[22] a study conducted at Mizan Tepi University Teaching Hospital, Ethiopia,[23] and a study conducted at Felege Hiwot Referral Hospital, Ethiopia.[24] The evidence of prolonged labor with uterine rupture was also identified in the study conducted in the Teaching Hospital of Rawalpindi.[27] The reason may be due to the possibility of obstruction and exhaustion of the uterine wall.

In this study, the odds of developing uterine rupture among mothers with big babies (in this study, ≥4000 g) was 5.6 times higher than those mothers with birth weights of <4000 g. This study has similarities with the study conducted in Turkey,[15] the study conducted in Dessie, Ethiopia,[21] the study conducted in Amhara regional state referral hospitals, Ethiopia,[22] and the study conducted in Norway.[28] The possible reason may be that when there is a big baby and insufficient maternal pelvis, it leads to CPD. At this time,

there is repeated contraction and relaxation without the advancement of labor exhaustion and end up with a uterine rupture. This is also supported by scientific background when there is a big baby, the mother's pelvic inlet cannot accommodate the baby part and can result in CPD, which can lead to uterine rupture.[9]

In this study, mothers with obstructed labor have the highest chance of developing a uterine rupture. Mothers who had obstructed labor have four times the risk of developing a uterine rupture as their counterparts. This finding was supported by the study conducted in Turkey,[15] and the studies conducted in Aira Hospital, Ethiopia,[13] Amhara regional hospitals, Ethiopia,[22] Suhul Shire General Hospital, Ethiopia,[29] Debremarkos Referral Hospital, Ethiopia,[30] Dessie Hospital, Ethiopia,[21] Mizan Tepi University Teaching Hospital, Ethiopia,[23] and a study conducted in Pakistan.[31] The possible reason may be due to compression of the uterus by the fetus for an extended period. Also, it might be because of service unavailability at different levels of health facilities, especially comprehensive emergency obstetric care and low utilization of the available maternal health services.

In this study, having a previous history of CS delivery is an independent predictor of uterine rupture. This finding is supported by the studies conducted in Adama city public and private hospitals, Ethiopia,[17] a study conducted in Dessie Referral Hospital, Ethiopia,[21] a study conducted in Mizan Aman General Hospital, Ethiopia,[10] and a study conducted in Amhara Regional State, Ethiopia.[22] This might be because most women with previous CS delivery are highly prone to developing scar dehiscence from the weak uterine wall as a result of pressure from the contracting uterus.

This study has revealed that, being not followed by a partograph increases the odds of developing uterine rupture by nine times. This finding is consistent with the studies conducted in Debremarkos Hospital, Ethiopia,[25] Amhara regional state referral hospitals, Ethiopia,[22] and the study conducted in Mizan Tepi University Teaching Hospital, Ethiopia.[23] This is because partograph utilization to monitor the progress of the feto-maternal condition will enable us to prevent the occurrence of prolonged labor. As a result, it prevents uterine rupture.

This study has also identified that, having no history of FGC decreases the odds of developing a uterine rupture by 81%. As investigators search, no study indicates the association of uterine rupture and the history of FGC. The reason for this link could be that scarring from previous FGC causes obstructed labor, which is the most common cause of uterine rupture.

Even though significant association with uterine rupture is indicated in other studies, in this study, variables like: age, average monthly income, distance from health facilities, pregnancy interval, antenatal care follow-up, presence of destructive delivery, mal presentation, failed induction, health professional follow-up, and number of antenatal care follow-up were not shown to have significant association with uterine rupture.

Limitations

- Participants might not give an exact response to sensitive questions like female genital mutilation, and this may lead to social desirability bias that may limit the accuracy of the data.
- Male partners were not included in the study as they are influential in women's reproductive health, like supporting mothers to visit the health facility for family planning or during their pregnancy for ANC and delivery.
- Because of the institutional-based nature of the study, the issue of generalizability of findings for the total population is difficult.

Conclusion and recommendations

The findings of this study show that living in rural areas, low MUAC status, having a big baby, prolonged labor, obstructed labor, history of previous CS, history of FGC, and not being followed by partograph were significantly associated with the occurrence of uterine rupture. Based on the study findings, the following recommendations were made:

- Hospitals should give attention to rural area residents, supply necessary logistics, and provide training for health professionals who follow laboring mothers, and strengthen the referral system.
- Health professionals should consider mothers having a history of FGC and previous CS scars during ANC follow up and laboring mothers to prevent prolonged and obstructed labor.
- To prevent malnutrition, health professionals should provide mothers with the necessary nutritional and dietary counseling during their pregnancy while keeping future pregnancies in mind.
- Appropriate use of the partograph is an important tool for monitoring the progress of labor and a warning device to detect deviations from normal labor to prevent obstructed labor as well as uterine rupture.
- All mothers also need to increase their early health-seeking behavior and also need to increase the habits of feeding their female children to prevent intergenerational malnutrition.
- Further studies, like follow-up studies to identify other independent risk factors related to the development of uterine rupture, are needed.

ORCID iD

Gemechu Kejela https://orcid.org/0000-0001-8284-487X

Supplemental material

Supplemental material for this article is available online.

References

1. Moldenhauer JS. MSD manual, 2019, https://www.msdmanuals.com/en-in/home/authors/moldenhauer-julie
2. Sunanda N and Ranganth P. A two-year analysis of uterine rupture in pregnancy. *Int J Reprod Contracept Obstet Gynecol* 2016; 5(11): 3983–3986.
3. Peker N, Yavuz M, Aydın E, et al. Risk factors for relaparotomy after cesarean section due to hemorrhage: a tertiary center experience. *J Matern Fetal Neonatal Med* 2020; 33(3): 464–470.
4. Peker N, Turan G, Aydın E, et al. Analysis of patients undergoing peripartum hysterectomy for obstetric causes according

to delivery methods: 13-year experience of a tertiary center. *Dicle Tip Dergisi* 2020; 47(1): 122–129.

5. Peker N, Yavuz M, Aydın E, et al. Bilateral hypogastric artery ligation: a tertiary center experience. *J Harran Univ Med Fac* 2019; 16(3): 526–529.

6. Getahun T, Workneh D, Hailu C, et al. The prevalence and outcomes of uterine rupture in Wolliso St. Luke Catholic Hospital, Oromia regional state, southwest Shewa, Ethiopia. *Med J Obstet Gynecol* 2018; 6: 1–6.

7. Desta M, Amha H, Anteneh Bishaw K, et al. Prevalence and predictors of uterine rupture among Ethiopian women: a systematic review and meta-analysis. *PLoS ONE* 2020; 15(11): e0240675.

8. Pansota MS, Ajmal A and Zaman BS. Rupture of uterus (fundus); spontaneous rupture of an unscarred uterus (fundus), at 35 weeks 01 day of gestation of a multigravida. *Prof Med J* 2016; 23: 114–117.

9. Pereira M and Ablett J. *Ruptured uterus guideline (GL908)*. London: Royal Berkshire NHS Foundation Trust, 2017, pp. 4–7.

10. Mengistie H, Amenu D, Hiko D, et al. Maternal and perinatal outcomes of uterine rupture patients among mothers who delivered at Mizan Aman General Hospital, SNNPR, south west Ethiopia; a five year retrospective hospital based study. *MOJ Womens Health* 2016; 2(1): 13–23.

11. Marie Bereka T, Mulat Aweke A and Eshetie Wondie T. Associated factors and outcome of uterine rupture at Suhul General Hospital, Shire town, north west Tigray, Ethiopia 2016: a case-control study. *Obstet Gynecol Int* 2017; 2017: 8272786.

12. Al Rukeimi AAD, Al Shaibani EM, Al Shamahy HA, et al. Uterine rupture and associated factors during labor amongst women delivered in Saudi Hajjah Hospital in Hajjah city north west Yemen. *World J Gynecol Womens Health* 2018; 1(2): 1–5.

13. Alemayehu W, Ballard K and Wright J. Primary repair of obstetric uterine rupture can be safely undertaken by non-specialist clinicians in rural Ethiopia: a case series of 386 women. *BJOG* 2013; 120(4): 505–508.

14. Qureshi S, Mishra U, Mishra P, et al. Maternal and fetal outcome in cases of rupture uterus: a retrospective study. *Eur J Pharm Med Res* 2017; 4(3): 294–301.

15. Peker N, Aydın E, Evsen MS, et al. Unscarred uterine rupture and subsequent pregnancy outcome – a tertiary centre experience. *Ginekol Pol* 2020; 91(2): 95–99.

16. Fitzpatrick KE, Kurinczuk JJ, Alfirevic Z, et al. Uterine rupture by intended mode of delivery in the UK: a national case-control study. *PLoS Med* 2012; 9(3): e1001184.

17. Abebe F, Mannekulih E, Megerso A, et al. Determinants of uterine rupture among cases of Adama city public and private hospitals, Oromia, Ethiopia: a case control study. *Reprod Health* 2018; 15(1): 161.

18. Abraham W and Berhan Y. Predictors of labor abnormalities in university hospital: unmatched case control study. *BMC Pregnancy Childbirth* 2014; 14: 256.

19. Vasundhara D, Hemalatha R, Sharma S, et al. Maternal MUAC and fetal outcome in an Indian tertiary care hospital: a prospective observational study. *Matern Child Nutr* 2020; 16(2): e12902.

20. Ikobho EH and Jeremiah I. Predictors of cephalopelvic disproportion in labour a tertiary hospital in Bayelsa state, Nigeria. *Niger J Med* 2018; 27(3): 1–7.

21. Workie A, Getachew Y, Temesgen K, et al. Determinants of uterine rupture in Dessie Referral Hospital, north east Ethiopia, 2016: case control design. *Int J Reprod Contracept Obstet Gynecol* 2018; 7(5): 1712–1717.

22. Getahun WT, Solomon AA, Kassie FY, et al. Uterine rupture among mothers admitted for obstetrics care and associated factors in referral hospitals of Amhara regional state, institution-based cross-sectional study, northern Ethiopia, 2013-2017. *PLoS ONE* 2018; 13(12): e0208470.

23. Yemane Y and Gizaw W. Assessment of the associated factors, management and complications of uterine rupture at Mizan-Tepi University Teaching Hospital, Mizan-Aman town, Bench-Maji zone, SNNPRS, south west Ethiopia, 2016/17: a case control study. *Health Sci J* 2017; 11(3): 1–9.

24. Wesson A and Assefa E. Maternal outcome following uterine rupture and its associated factors among mothers who delivered at Felege-Hiwot Referral Hospital, Amhara-Ethiopia. *Int J Sci Rep* 2018; 5(1): 9.

25. Sa A, Tk Y, Tb L, et al. Prevalence and associated factors of uterine rupture during labor among women who delivered in Debre Markos Hospital north west Ethiopia. *J Intern Med* 2020; 6(4): 1–6.

26. Tang AM, Chung M, Dong K, et al. Determining a global mid-upper arm circumference cutoff to assess malnutrition in pregnant women, 2016, https://www.fantaproject.org/sites/default/files/resources/FANTA-MUAC-cutoffs-pregnant-women-June2016.pdf

27. Ara J, Naheed K, Kazmi F, et al. Uterine rupture: a catastrophic complication. *J Rawalpindi Med Coll* 2010; 14(1): 36–39.

28. Al-Zirqi I, Daltveit AK, Forsén L, et al. Risk factors for complete uterine rupture. *Am J Obstet Gynecol* 2017; 216(2): 165.e1–165.e8.

29. Gebre S and Negassi A. Risk factors for uterine rupture in Suhul General Hospital case control study. *Electr J Biol* 2017; 13(3): 198–202.

30. Astatikie G, Limenih MA and Kebede M. Maternal and fetal outcomes of uterine rupture and factors associated with maternal death secondary to uterine rupture. *BMC Pregnancy Childbirth* 2017; 17(1): 117.

31. Qazi Q, Akhtar Z, Khan K, et al. Woman health; uterus rupture, its complications and management in teaching hospital Bannu, Pakistan. *Maedica* 2012; 7(1): 49–53.