

Determinants of Premature Rupture of Membranes Among Pregnant Women Admitted to Public Hospitals in Southern Ethiopia, 2020: A Hospital-Based Case–Control Study

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Background: A gush of amniotic fluid any time before the onset of labor is known as premature rupture of the membranes (PROM). Its consequences vary from maternal and neonatal mortality and morbidity to country-wide economic loss. At the national level in general, and in the study area in particular, little is known about PROM and its determinants. Hence, this study aimed at identifying determinants of PROM among pregnant women admitted to public hospitals in Southern Ethiopia, 2020.

Methods and Materials: A hospital-based unmatched case–control study was conducted on 279 pregnant women (93 cases and 186 controls) admitted to public hospitals from October 1 to 30, 2020. Pregnant women admitted to maternity wards of selected hospitals with a painless gush of fluid spilling out from the vaginal canal were considered as cases. Interviewer-administered questionnaires and data abstraction tools were used to collect data. The data were coded and entered into Epi-Data version 3.1 and exported to SPSS version 23 for analysis. The determinants of PROM were identified by applying a multivariable logistic regression analysis at a p-value <0.05.

Results: Term PROM accounted for the majority, 55 (59.2%) of cases. Previous history of abortion (AOR: 4.14, 95% CI: 2.21–9.07), lack of ANC (AOR: 3.51; 95% CI: 1.33–8.27), previous history of PROM (AOR: 4.91; 95% CI: 2.23–9.82), caesarean delivery (AOR: 3.02, 95% CI: 1.24–6.40), using of a maternal waiting room (MWR) (AOR: 0.33, 95% CI: 0.15–0.74), and mid-upper arm Circumference (MAUC) <23cm (AOR: 3.69, 95% CI: 1.58–8.64) were identified as significant determinants of PROM.

Conclusion: Health-care providers should work on providing adequate ANC by tracing mothers who have not received it and advising pregnant women to use MWR in the final weeks of their pregnancy. Furthermore, maternal and child health care units must place a strong focus on screening and managing the nutritional status of pregnant women. Furthermore, women with a history of abortion, caesarean section, and PROM need due attention from health care providers to mitigate the occurrence of PROM.

Keywords: PROM, determinants, case-control, public hospitals, Ethiopia

Background

A fluid-filled sac called the bag of water or amniotic fluid covers the developing baby.¹ Amniotic fluid is usually produced continuously, but after about 16 weeks of pregnancy, fetal urine production takes over. It defends against infection, fetal

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trauma, and compression of the umbilical cord. Compression of the umbilical cord and reduced placental blood flow may occur when amniotic fluid is low or absent.^{1,2}

Deliveries before 37 weeks of gestation (or preterm deliveries) are a global health concern, as per the World Health Organization (WHO).^{1,3} Premature Rupture of Membrane (PROM) is a painless gush of amniotic fluid any time before the onset of labor from the vaginal canal with or without a decrease in the size of the uterus.⁴ It is supported by a basic pH test of vaginal fluid or ferning of dried vaginal fluid detected under microscopic evaluation and a decrease in amniotic fluid volume (AFV) of <5cm during an ultrasound examination.⁵ Preterm premature rupture of membranes (PPROM) refers to PROM that occurs before 37 weeks of pregnancy, while term premature rupture of membranes refers to PROM that occurs after 37 weeks of pregnancy.^{1,2,4} In Ethiopia, it is defined as a gush of amniotic fluid before the onset of labor in the period after 28 weeks of pregnancy (after fetal viability), since the rupture of the membrane before the 28th week of pregnancy is considered an automatic abortion.⁶

PROM affects about 5% to 10% of all births, while PPRM affects about 3%. Around 70% of PROM cases occur in full-term pregnancies, but in referral centers, more than 50% of cases may occur in preterm pregnancies.⁷⁻⁹ According to studies, PROM raises perinatal mortality by four times and neonatal morbidity by three times.¹⁰

Premature rupture of membranes is the common complication of pregnancy which is an important cause for perinatal and maternal morbidity and mortality. The consequences of PROM vary from maternal and neonatal mortality and morbidity to countrywide economic loss due to medication cost, hospital admission, absences from the job, and cost to the health professionals.¹¹⁻¹³ PROM complicates 3-8% of births and leads to one-third of prematurity and 90% of deaths.^{13,14} Intraventricular hemorrhage, neonatal sepsis, and respiratory distress syndrome are neonatal complications due to prematurity that account for the majority of neonatal deaths.¹³⁻¹⁷ It also triggers significant maternal complications including puerperal infections, disseminated intravascular coagulopathy (DIC), placental abruption, surgical delivery, chorioamnionitis, and mental and breastfeeding issues.^{18,19} The longer the time between rupture and delivery, the higher the risk of maternal and fetal morbidity, as well as a higher risk of maternal, fetal, and fetal mortality.²⁰

PROM was found to be 13.8% in rural Uganda²¹ and 1.94% in rural Nigeria,²⁰ according to studies. According to hospital-based studies conducted in Northern and Western Ethiopia, the magnitude of PROM was found to be 13.7% and 13.4%, respectively.^{22,23}

Since the purpose of PROM management is to prolong pregnancy, the most typical management scheme for pregnant women with a gestational age of fewer than 36 weeks is expectant, which involves admitting the patient to the hospital and monitoring for signs of sickness, fetal distress, or labor to allow the fetus enough time to grow and mature.²⁴⁻²⁶ The specific cause of PROM is unspecified. Different studies indicated that bad past pregnancy outcomes, uterine overdistention, smoking, low BMI, genitourinary tract infection, poor diet, and assisted fertility are the major contributing factors for PROM.²⁷⁻²⁹

It is hard to understate the significance of identifying and understanding the determinants of PROM for the pregnancy's future outcome. A missed opportunity for effective intervention may result from a late diagnosis.^{10,30} To the best of the investigators' knowledge and based on a review of the literature, very little is known about PROM and its determinants at the national level, with no study specifically undertaken in the current study area. Identifying and intervening on the determinants can help to prevent PROM from occurring in the future, reducing maternal and newborn complications. The findings could potentially be used as a roadmap for improving maternal and newborn health in the study area, resulting in a reduction in maternal and neonatal mortality across the country and the continent. Hence, this study aimed at identifying the determinants of PROM among pregnant women admitted to public hospitals in the Guraghe zone, southern Ethiopia.

Methods and Materials

Study Settings, Design, and Period

A hospital-based unmatched case-control study was conducted in public Hospitals of Guraghe Zone, Southern Ethiopia from October 1-30, 2020. The zone is situated 158 kilometers south of Addis Ababa, Ethiopia's capital city, and 337 kilometers south of Hawassa (capital of southern Ethiopia region). The total population of the zone in the fiscal year 2020 was 1,835,110, with 19.84% of women in the reproductive age group (15-49 years old) and 63,495 expected live births. There are 527 health

facilities, comprising 74 clinics, 9 hospitals, and 444 health posts.

The Population of the Study

The source population were all mothers with a gestational age of more than 28 weeks and admitted to labor, maternity, and high-risk wards of public hospitals in the zone. The study populations for cases were selected women who were admitted to labor, maternity, and high-risk wards of selected hospitals with a painless gush of fluid that spills out of the vagina and a shift in color or a decrease in the size of the uterus. The study population for controls were those selected pregnant mothers with a gestational age of more than 28 weeks and admitted to the same wards of the selected hospitals without any of the above signs during the study period. Those mothers who were initially assigned to the control group but later switched to the case group were excluded from the study. Participants with a gestational age of fewer than 28 weeks, as well as those who were seriously ill during the data collection period, were excluded.

Sample Size Determination

The sample size was determined using the StatCalc menu of Epi Info version 7 statistical software for an unmatched case-control study. The following assumptions were used: a 95% confidence level, an 80% power, a case-to-control ratio of 1:2, a percent of exposure among controls exposed (proportion of CS among women without PROM), and a percent of exposure among cases (proportion of CS among women with PROM). The percent of cases exposed for CS (16.2%) and percent of controls exposed for CS (4.4%) was taken from a study conducted in northern Ethiopia.²⁸ Based on the above assumptions, the sample size was 252 (84 cases and 168 controls), and after adding for a 10% nonresponse rate, the final sample size for the study was 279 (93 cases and 186 controls).

Sampling Techniques

Of the nine, five public hospitals in the zone were selected by lottery method namely: Butajira Teaching and Referral Hospital, Wolkite Teaching and Referral Hospital, Buie General Hospital, Quante General Hospital, and Atat Saint Lurd Referral Hospital. Obstetric case management reports and registration books were observed over the last three months before the data collection period to assess the obstetric client/patient flow rate of the respective hospitals. The sample size was proportionally allocated amongst

these selected hospitals based on their case-flow over the previous three months as follows: Butajira Teaching and Referral Hospital (23 cases and 46 controls), Atat Saint Lurd Referral Hospital (32 cases and 64 controls), Wolkite Teaching and Referral Hospital (25 cases and 50 controls), Buie General Hospital (7 cases and 14 controls), and Quante General Hospital (6 cases and 12 controls). Cases were recruited consecutively until the calculated sample size was achieved. A systematic sampling method was used to select and interview two controls for each case. The interval (K) was calculated by dividing the average number of controls who visited each hospital in the previous three months by the proportionally allocated control sample size.

Data Collection Tools, Methods, and Personnel

A standardized, structured, interviewer-administered questionnaire comprising socio-demographic variables, obstetric conditions, maternal health service-related characteristics, and medical condition was developed after reviewing literature in the area of interest.^{2,10,28,31} The data were collected by five trained BSc Midwives with experience in data collection, under the supervision of three public health officers, through face-to-face interviews. A tool adapted from the Ethiopian Demographic and Health Survey 2016 Report was used to assess the socioeconomic status of households.³² Medical and obstetric data that could not be accessed by interviews, such as gestational age, diagnosis of PROM, urinary tract infections, STIs, anemia, and hypertensive disorders of pregnancy, were collected from patient medical records and charts. The mothers' middle upper arm circumference (MUAC) was measured using non-elastic, non-stretchable MUAC tapes placed at the midpoint between the tips of the left arm's shoulder and elbow, and the measurement was taken to the nearest 0.1Centimeters.

Data Quality Management

Initially, the data collection questionnaire is prepared in English and then translated into the local language by an expert in that language. It was then back-translated into English to ensure consistency with the original meanings. About data collection methods and instruments, both data collectors and supervisors provided one-day training. A pre-test was conducted in Woliso Christian Hospital one week before the actual data collection for 5% of the

sample size (5 cases and 10 controls). The reliability of the questionnaires was assessed and the reliability index for practical questions (Cronbach's alpha), which was 0.79. Based on the pre-test result, all relevant corrections were made. Every day, after data collection, the supervisors and principal investigator checked and verified each questionnaire for completeness and supplemented it with feedback.

Data Analysis

The data entered and coded into EpiData Version 3.1 was exported to SPSS version 23 for analysis. Univariate analyses such as frequency, proportion, mean, and standard deviation were computed for both cases and controls. The Chi-square test was conducted to test the statistical significance between dependent and independent variables. The wealth status of each household was evaluated using principal component analysis (PCA). There were a total of 28 items used in the beginning. Kaiser-Meyer-Olkin's (KMO) sampling adequacy measure (≥ 0.6), Bartlett's Sphericity test ($p\text{-value} < 0.05$), and anti-image correlations (> 0.4) have all been used to ensure that PCA's assumptions were met. At each step, variables with communalities less than 0.5 and complex structures (correlations greater than 0.4 in more than one component) were removed until the iterations met the requirements. Finally, three components were derived from the PCA that accounted for 68.9% of the overall variance and were used to divide study participants' household wealth into quintiles.

The proportion of cases and controls between selected categorical variables was compared using the Chi-square test. Bivariable and multivariable logistic regression analyses have been used to identify the determinants of PROM. The strength of the association was measured using an odds ratio with a 95% confidence interval. A bivariable logistic regression model was used to determine the relationship between each independent variable and the dependent variable. To manage confounding factors and see the independent predictors of PROM, variables with a P-value of 0.25 in bivariate logistic regression were exported to a multivariable logistic regression model. The adjusted odds ratio with a 95% confidence interval was used to report the association between the outcome and explanatory variables, and the statistical significance was declared at a p-value of 0.05. Model fitness was measured using the Hosmer and Lemeshow goodness of fit measures, as well as the Nagelkerke R Square, which were 0.64 and 0.58,

respectively. The variance inflation factor ($VIF > 10$) was used to test for multicollinearity between the explanatory variables.

Measurement of Variables of the Study

Outcome Variable

Premature rupture of membrane (PROM): the dependent variable, was confirmed by sterile speculum examination and clinical features (painless gush of fluid that spills out of the vagina and a shift in color or a decrease in the size of the uterus).^{1,2,4,28} A basic pH test of vaginal fluid or ferning of dried vaginal fluid detected under microscopic evaluation and decrease in amniotic fluid volume (AFV) of $< 5\text{cm}$ during ultrasound examination also supported the diagnosis.^{5,22} Cases comprised mothers with gestational age 28 weeks and above who were admitted to the labor, Maternity, and high-risk ward and had PROM before the onset of labor, as diagnosed by general practitioners (GPs), gynecologists, or residents. Controls, on the other hand, were pregnant mothers of gestational age > 28 weeks who were admitted to those wards and had no rupture of membranes before the onset of labor.

Explanatory Variables

Poor nutritional status: A mother with a Mid Upper Arm Circumference (MUAC) $< 23\text{ cm}$.²²

Anemia: A pregnant woman whose Haemoglobin level $< 11\text{ gm/dl}$ was considered as an anemic.

Heavy weight lifting during pregnancy: is considered when a woman lifts 26 lbs (12Kg) infrequently (less than once every 5 minutes), less than an hour of repetitive lifting of 22lbs (10Kg) a day, and more than 1 hour of repetitive lifting of 13 lbs (6kg) a day after 28 weeks of the current pregnancy.²

An adequate sleeping hour during pregnancy: when a woman can sleep more than 8 hours per day.²⁸

Maternal waiting room (MWR): A home or residential facility near a hospital or a health center that offers emergency obstetric care (EmOC) with skilled birth attendants to women who are far from facilities and stayed there in their final weeks of pregnancy.^{33,34}

MWR utilization: In this study, a woman was deemed an MWR user if she stayed in any of the maternal waiting rooms in hospitals before the onset of labor, whether she was near term or at term, and regardless of how long she stayed at home during the current pregnancy.^{33,35}

Results

Socio-Demographic Characteristics of the Respondents

A total of 279 respondents were enrolled in the study (93 cases and 186 controls), with a 100% response rate. The cases and controls had mean (SD) ages of 29.81 (± 5.48) and 29.56 (± 4.75) years, respectively. The majority of cases (63.4%) and controls (83.3%) were between the age group 20–34 years. Over half of the cases (52.7%) were from rural communities, while the majority of the controls (63.4%) were from urban areas. In terms of educational status, almost half of the cases, 46 (49.5%), and

65 (34.9%) of controls have no formal education. The difference in educational level between cases and controls was statistically significant, according to the Chi-square test. In contrast to controls (15.0%), a relatively high proportion of cases (29.0%) were in the lowest wealth quintiles (Table 1).

Obstetric Characteristics of Respondents

Between cases and controls, there was no substantial difference in the proportions of Primigravida and Nulliparous respondents. The majority of cases, 43 (46.2%), and controls, 101 (54.4%), were multiparas, with 2–4 living

Table 1 Socio-Demographic and Economic Characteristics of Respondents Admitted to Public Hospitals in Guraghe Zone, Southern Ethiopia, 2020

Variables	Categories	Cases=93 n (%)	Controls=186 n (%)	Total =279 n (%)	X ²	P-value
Age of mother in years	15–19	10 (10.8)	15 (8.1)	25 (8.9)	16.49	<0.001
	20–34	59 (63.4)	155 (83.3)	214 (76.7)		
	≥35	24 (25.8)	16 (8.6)	40 (14.4)		
Residence	Urban	44 (47.3)	118 (63.4)	162 (58.1)	6.624	0.007
	Rural	49 (52.7)	68 (36.6)	117 (41.9)		
Marital status	In marital union	85 (91.4)	175 (94.1)	260 (93.2)	0.401	0.452
	Not in marital relation	8 (8.6)	11 (5.9)	19 (6.8)		
Religion	Orthodox	38 (40.9)	84 (45.2)	122 (43.7)	0.692	0.875
	Muslim	31 (33.3)	54 (29.0)	85 (30.5)		
	Protestant	20 (21.5)	41 (22.0)	61 (21.9)		
	Catholic	4 (4.3)	7 (3.8)	11 (3.9)		
Ethnicity	Guraghe	77 (82.8)	162 (87.1)	239 (85.7)	1.705	0.426
	Amhara	10 (10.8)	18 (9.7)	28 (10.0)		
	Others*	6 (6.4)	6 (3.2)	12 (4.3)		
Mother's Educational level	No formal education	46 (49.5)	65 (34.9)	111 (39.8)	11.696	0.009
	Primary education (1–8th)	23 (24.7)	35 (18.8)	58 (20.8)		
	Secondary(9–12th)	12 (12.9)	53 (28.5)	65 (23.3)		
	College and above	12 (12.9)	33 (17.8)	45 (16.1)		
Husband's Education	No formal education	26 (27.9)	66 (35.5)	92 (33.0)	1.877	0.598
	Primary education (1–8th)	33 (35.5)	62 (33.3)	95 (34.0)		
	Secondary(9–12th)	19 (20.4)	35 (18.8)	54 (19.4)		
	College and above	15 (16.2)	23 (12.4)	38 (13.6)		
Wealth index	Highest	13 (14.0)	43 (23.1)	56 (20.1)	10.058	0.039
	Fourth	16 (17.2)	40 (21.5)	56 (20.1)		
	Middle	16 (17.2)	39 (21.0)	55 (19.7)		
	Second	21 (22.6)	36 (19.4)	57 (20.4)		
	Lowest	27 (29.0)	28 (15.0)	55 (19.7)		
Family size	<5	45 (48.4)	101 (54.3)	146 (52.3)	0.869	0.351
	≥5	48 (51.6)	85 (45.7)	133 (47.7)		

Note: *Tigri, Oromo.

children. Both cases and controls had experienced a comparable number of five or more pregnancies, 35.5%, and 32.3%, respectively. Twenty-seven (29.1%) cases and 21 (11.3%) controls had at least one previous history of abortion, with spontaneous abortion accounting for the most common type of abortion, in 21 (77.8%) of cases and 13 (61.9%) of controls. About a quarter of cases (25.6%) and one-tenth of controls (19.2%) have had at least one cesarean delivery. A prior history of PROM was reported in 35 (37.6%) of the cases and 20 (10.8%) of the controls (Table 2).

Maternal Health Service-Related Characteristics

The proportion of cases without ANC was double that of controls, at 26 (27.9%) and 26 (14.0%), respectively. A comparable proportion of cases, 56 (60.2%), and 119 (59.7%) of controls utilized modern contraceptives, in which injectables were the most common method-mix used by 19 (33.9%) and 49 (44.2%) of cases and controls, respectively. A few respondents in both cases (5.4%) and controls (5.7%) had previously undergone cervical cerclage. Fifty (53.8%) of cases and 102 (54.8%) of controls reached a health facility

Table 2 Obstetric Characteristics of Respondents Admitted to Public Hospitals in Guraghe Zone, Southern Ethiopia, 2020

Variables	Categories	Cases=93	Controls=186	Total =279	X ²	P-value
		n(%)	n(%)	n (%)		
Gestational age in weeks	<37(Preterm) 37–42(Term) >42(Post-term)	23 (24.7) 55 (59.2) 15 (16.1)	42 (22.6) 115 (61.8) 29 (15.6)	65 (23.3) 170 (60.9) 44 (15.8)	0.208	0.901
Gravidity	I 2–4 ≥5	10 (10.7) 50 (53.8) 33 (35.5)	23 (12.4) 104 (55.9) 59 (32.3)	33 (11.8) 154 (55.2) 92 (33.0)	0.455	0.797
Parity	0(Nulliparous) I(Primiparous) 2–4(Multiparous) ≥5(Grand multiparous)	15 (16.1) 11 (11.8) 43 (46.2) 24 (25.8)	35 (18.8) 23 (12.3) 101 (54.4) 27 (14.5)	50 (17.9) 34 (12.2) 144 (51.6) 51 (18.3)	5.369	0.147
Desire on the last pregnancy	Planned Not planned	60 (64.5) 33 (35.5)	130 (69.9) 56 (30.1)	190 (68.1) 89 (31.9)	0.825	0.364
History of multiple pregnancies(n=246)	Yes No	7 (8.4) 76 (91.6)	10 (6.1) 153 (93.9)	17 (6.9) 229 (93.1)	0.452	0.502
Ever had abortion	Yes No	27 (29.1) 66 (70.9)	21 (11.3) 165 (88.7)	48 (17.2) 231 (82.8)	13.701	<0.001
Frequency of abortion (n=48)	I 2 times 3 times	22 (81.5) 4 (14.8) 1 (3.7)	14 (66.7) 6 (28.6) 1 (4.7)	36 (75.0) 10 (20.8) 2 (4.2)		
Types of abortion(n=48)	Spontaneous Induced Both	21 (77.8) 5 (18.5) 1 (3.7)	13 (61.9) 7 (33.3) 1 (4.8)	34 (70.8) 12 (25.0) 2 (4.2)		
Previous history PROM	Yes No	35 (37.6) 58 (62.4)	20 (10.8) 166 (89.2)	55 (19.7) 224 (80.3)	28.308	<0.001
Previous history of preterm birth	Yes No	19 (20.4) 74 (79.6)	16 (8.6) 170 (91.4)	35 (12.6) 244 (87.4)	7.906	0.005
Previous history of C/S	Yes No	24 (25.8) 69 (74.2)	19 (10.2) 167 (89.8)	43 (15.4) 236 (84.6)	11.560	0.001

Table 3 Maternal Health Service-Related Characteristics of Respondents Admitted to Public Hospitals in Guraghe Zone, Southern Ethiopia, 2020

Variables	Categories	Cases=93	Controls=186	Total =279	χ^2	P-value
		n(%)	n(%)	n (%)		
ANC visit	≥4	17 (18.3)	54 (29.0)	71 (25.5)	16.129	0.001
	2–3	19 (20.4)	64 (34.4)	83 (29.8)		
	I	31 (33.4)	42 (22.6)	73 (26.1)		
	No	26 (27.9)	26 (14.0)	52 (18.6)		
Place of ANC	Health center	38 (57.6)	110 (68.3)	148 (65.2)	2.150	0.670
	Hospital	28 (42.4)	51 (31.7)	79 (34.8)		
ANC providers	Midwives	30 (45.5)	87 (38.3)	117 (51.5)	1.229	0.724
	Public health officers	24 (36.4)	50 (22.1)	74 (32.6)		
	Nurses	7 (10.6)	14 (6.2)	21 (9.3)		
	Doctors	5 (7.6)	10 (4.4)	15 (6.6)		
Place of last delivery (n=247)	Health center	57 (68.7)	114 (69.9)	171 (69.5)	0.179	0.915
	Hospital	16 (19.3)	28 (17.2)	44 (17.9)		
	Home	10 (12.0)	21 (12.9)	31 (12.6)		
Mode of delivery for the last birth (n=246)	SVD	38 (45.8)	87 (53.4)	125 (50.8)	1.311	0.519
	Instrumental delivery	33 (39.8)	57 (35.0)	90 (36.6)		
	C/S	12 (14.4)	19 (11.6)	31 (12.6)		
Cervical cerclage	Yes	5 (5.4)	5 (2.7)	10 (3.6)	1.296	0.255
	No	88 (94.6)	181 (97.3)	269 (96.4)		
Use of modern contraceptives	Yes	56 (60.2)	111 (59.7)	167 (59.9)	0.007	0.931
	No	37 (39.8)	75 (40.3)	112 (40.1)		
Last used Contraceptive method (n=167)	Oral contraceptives	14 (25.0)	24 (21.6)	38 (22.8)	2.344	0.504
	Injectables	19 (33.9)	49 (44.2)	68 (40.7)		
	Implants	18 (32.1)	26 (23.4)	44 (26.3)		
	IUCD	5 (9.0)	12 (10.8)	17 (10.2)		
Time spent to reach the nearby Health Facility	<1hr	43 (46.2)	84 (45.2)	127 (45.5)	0.029	0.865
	≥1hr	50 (53.8)	102 (54.8)	152 (54.5)		
Using maternal waiting room	No	72 (77.4)	121 (65.1)	193 (69.2)	4.446	0.039
	Yes	21 (22.5)	65 (34.9)	86 (30.8)		

after traveling a distance that takes one hour and more (Table 3).

Clinical and Medical Conditions of the Respondents

A large difference was observed in the mid-upper arm circumference (MUAC) measurement, in which 29 (31.2%) of cases and 18 (9.7%) of controls measuring less than 23 cm. About a fifth (20.4%) of cases and 22 (11.8%) of controls reported abnormal vaginal discharge during the current pregnancy and a limited number of

cases (5.4%) and controls (3.2%) were diagnosed with a genital ulcer (Table 4).

Risky Physical Activities and Habits Among Respondents

Twenty-one (22.6%) and twenty-one (11.3%) of the incidents and controls, respectively, had a history of falling down injuries. In both cases and controls, the number of smokers was low. Only 18.3% of cases and 15.0% of controls had intercourse during the third trimester. The majority of cases and controls have no history of chronic

Table 4 Clinical and Medical Conditions of Respondents Admitted to Public Hospitals in Guraghe Zone, Southern Ethiopia, 2020

Variables	Categories	Cases=93	Controls=186	Total =279	χ^2	P-value
		n(%)	n(%)	n (%)		
Having a chronic cough	Yes No	20 (21.5) 73 (78.5)	32 (17.2) 154 (82.8)	52 (18.6) 227 (81.4)	1.341	0.251
Having abnormal vaginal discharge during this pregnancy	Yes No	19 (20.4) 74 (79.6)	22 (11.8) 164 (88.2)	41 (14.7) 238 (85.3)	3.660	0.056
History of Genital ulcer during this pregnancy	Yes No	5 (5.4) 88 (94.6)	6 (3.2) 180 (96.8)	11 (3.9) 268 (96.1)	0.293	0.588
Diagnosed polyhydramnios	Yes No	8 (8.6) 85 (91.4)	14 (7.5) 172 (92.5)	22 (7.9) 257 (92.1)	0.099	0.753
Hemoglobin(gm/dl)	<11 ≥11	18 (19.4) 75 (80.6)	24 (12.9) 162 (87.1)	42 (15.1) 237 (84.9)	2.018	0.160
MUAC(Cm)	<23 ≥23	29 (31.2) 64 (68.8)	18 (9.7) 168 (90.3)	47 (16.8) 232 (83.2)	20.470	<0.001
Having a Pregnancy-induced hypertension(PIH)	Yes No	16 (17.2) 77 (82.8)	21 (11.3) 165 (88.7)	37 (13.3) 242 (86.7)	1.885	0.170

Table 5 Risky Physical Activities and Habits Among Respondents Admitted to Public Hospitals in Guraghe Zone, Southern Ethiopia, 2020

Variables	Categories	Cases=93	Controls=186	Total =279	χ^2	P-value
		n(%)	n(%)	n (%)		
Accidental fall during pregnancy	Yes No	21 (22.6) 72 (77.4)	21 (11.3) 165 (88.7)	42 (15.1) 237 (84.9)	6.180	0.013
Smoking	Yes No	4 (4.3) 89 (95.7)	5 (2.7) 181 (97.3)	9 (3.2) 270 (96.8)	0.517	0.472
Heavy load lifting	Yes No	27 (29.1) 66 (70.9)	41 (22.0) 145 (78.0)	68 (24.4) 211 (75.6)	1.643	0.200
Sleeping hours/day	<8hr ≥8hr	25 (26.9) 68 (73.1)	54 (29.1) 132 (70.1)	79 (28.3) 200 (71.7)	0.141	0.707
Alcohol consumption	Yes No	10 (10.8) 83 (89.2)	13 (7.0) 173 (93.0)	23 (8.2) 256 (91.8)	1.160	0.281
Having help at home	No Yes	30 (32.3) 63 (67.7)	43 (23.1) 143 (76.9)	73 (26.2) 206 (73.8)	2.681	0.102
Who help you?	Husband Maid Family	49 (77.8) 12 (19.0) 2 (3.2)	106 (74.1) 32 (22.4) 5 (3.5)	155 (75.2) 44 (21.4) 7 (3.4)	2.985	0.394
Having sexual intercourse in 3rd trimester	Yes No	17 (18.3) 76 (81.7)	28 (15.0) 158 (84.9)	45 (16.1) 234 (83.9)	0.477	0.490

Table 6 Determinants of PROM Among Women Admitted to Public Hospitals in Guraghe Zone, Southern Ethiopia, 2020

Variable	Categories	PROM		COR(95% CI)	AOR(95% CI)	p-value
		Cases (%)	Controls (%)			
Age of mother in years	15–19	10 (10.8)	15 (8.1)	1	1	1
	20–34	59 (63.4)	155 (83.3)	0.57 (0.24,1.34)	0.41 (0.12,1.39)	0.166
	≥35	24 (25.8)	16 (8.6)	2.25 (0.81,6.24)*	1.01 (0.23, 4.41)	0.887
Residence	Urban	44 (47.3)	118 (63.4)	1	1	1
	Rural	49 (52.7)	68 (36.6)	1.93 (1.17,3.20)*	1.84 (0.94,3.59)	0.074
Marital status	In marital union	85 (91.4)	175 (94.1)	1		
	Not in marital relation	8 (8.6)	11 (5.9)	0.67 (0.26,1.72)		
Mother's Educational level	College and above	12 (12.9)	33 (17.8)	1	1	1
	Secondary(9–12th)	12 (12.9)	53 (28.5)	0.62 (0.25,1.55)	0.76 (0.25,2.33)	0.629
	Primary education (1–8th)	23 (24.7)	35 (18.8)	1.81 (0.78,4.21)	1.30 (0.44,3.79)	0.631
	No formal education	46 (49.5)	65 (34.9)	1.95 (0.91,4.17)*	1.78 (0.68,4.64)	0.237
Family size	<5	45 (48.4)	101 (54.3)	1		
	≥5	48 (51.6)	85 (45.7)	1.27 (0.77,2.09)		
Husband's Education	College and above	15 (16.2)	23 (12.4)	1		
	Secondary(9–12th)	19 (20.4)	35 (18.8)	0.83 (0.35,1.96)		
	Primary education (1–8th)	33 (35.5)	62 (33.3)	0.82 (0.38,1.77)		
	No formal education	26 (27.9)	66 (35.5)	0.60 (0.27,1.34)		
Wealth index	Highest	13 (14.0)	43 (23.1)	1	1	1
	Fourth	16 (17.2)	40 (21.5)	1.32 (0.57,3.09)	1.34 (0.47,3.83)	0.587
	Middle	16 (17.2)	39 (21.0)	1.36 (0.58,3.18)	1.44 (0.52,3.99)	0.479
	Second	21 (22.6)	36 (19.4)	1.93 (0.85,4.38)*	1.72 (0.62,4.77)	0.296
	Lowest	27 (29.0)	28 (15.0)	3.19 (1.41,7.20)*	2.52 (0.93,6.84)	0.069
Gravidity	1	10 (10.7)	23 (12.4)	1		
	2–4	50 (53.8)	104 (55.9)	1.11 (0.49,2.49)		
	≥5	33 (35.5)	59 (32.3)	1.28 (0.55,3.03)		
Parity	0(Nulliparous)	15 (16.1)	35 (18.8)	1	1	1
	1(Primiparous)	11 (11.8)	23 (12.3)	1.12 (0.44,2.85)	1.29 (0.36,3.66)	0.700
	2–4(Multiparous)	43 (46.2)	101 (54.4)	0.99 (0.49,2.00)	1.66 (0.61,4.53)	0.319
	≥5(Grand multiparous)	24 (25.8)	27 (14.5)	2.07 (0.91,4.69)*	2.25 (0.68,6.46)	0.184
Desire on the last pregnancy	Planned	60 (64.5)	130 (69.9)	1		
	Not planned	33 (35.5)	56 (30.1)	1.28 (0.75,2.16)		
History of multiple pregnancy(n=246)	No	76 (91.6)	153 (93.9)	1		
	Yes	7 (8.4)	10 (6.1)	1.41 (0.52,3.85)		
Ever had abortion	No	66 (70.9)	165 (88.7)	1	1	1
	Yes	27 (29.1)	21 (11.3)	3.21 (1.69,6.08)*	4.14 (1.70,9.07) ^s	0.002
Previous history PROM	No	58 (62.4)	166 (89.2)	1	1	1
	Yes	35 (37.6)	20 (10.8)	5.01 (2.68,9.36)*	4.91 (2.23,9.82) ^s	<0.001
Previous history of C/S	No	69 (74.2)	167 (89.8)	1	1	1
	Yes	24 (25.8)	19 (10.2)	3.06 (1.57,5.94)*	3.02 (1.24,7.40) ^s	0.015

(Continued)

Table 6 (Continued).

Variable	Categories	PROM		COR(95% CI)	AOR(95% CI)	p-value
		Cases (%)	Controls (%)			
ANC visit	≥4	17 (18.3)	54 (29.0)	I	I	I
	2–3	19 (20.4)	64 (34.4)	0.94 (0.45,1.99)	0.80 (0.31,2.10)	0.652
	I	31 (33.4)	42 (22.6)	2.34 (1.15,4.79)*	1.58 (0.63,3.97)	0.332
	No	26 (27.9)	26 (14.0)	3.17 (1.47,6.86)*	3.51 (1.33,8.27) ^s	0.011
Mode of delivery for the last birth (n=246)	SVD	38 (45.8)	87 (53.4)	I		
	Instrumental delivery	33 (39.8)	57 (35.0)	1.32 (0.75,2.35)		
	C/S	12 (14.4)	19 (11.6)	1.45 (0.64,3.27)		
Using maternal waiting room	No	72 (77.4)	121 (65.1)	I	I	I
	Yes	21 (22.5)	65 (34.9)	0.54 (0.31,0.96)*	0.33 (0.15,0.74) ^s	0.007
Having a chronic cough	No	73 (78.5)	154 (82.8)	I		
	Yes	20 (21.5)	32 (17.2)	1.32 (0.71,2.46)		
Abnormal vaginal discharge during this pregnancy	No	74 (79.6)	164 (88.2)	I	I	I
	Yes	19 (20.4)	22 (11.8)	1.91 (0.98,3.75)*	2.26 (0.86,5.93)	0.096
Diagnosed polyhydramnios	No	85 (91.4)	172 (92.5)	I		
	Yes	8 (8.6)	14 (7.5)	1.16 (0.47,2.86)		
Hemoglobin(gm/dl)	≥11	75 (80.6)	162 (87.1)	I	I	0.677
	<11	18 (19.4)	24 (12.9)	1.62 (0.83,3.16)*	1.23 (0.47,3.19)	
MUAC(Cm)	≥23	64 (68.8)	168 (90.3)	I	I	I
	<23	29 (31.2)	18 (9.7)	4.23 (2.19,8.14)*	3.69 (1.58,8.64) ^s	0.003
Having Pregnancy-induced hypertension(PIH)	No	77 (82.8)	165 (88.7)	I		
	Yes	16 (17.2)	21 (11.3)	1.63 (0.81,3.30)		
Having sexual intercourse in 3rd trimester	No	76 (81.7)	158 (84.9)	I		
	Yes	17 (18.3)	28 (15.0)	1.26 (0.65,2.45)		
Lifting Heavyweight	No	66 (70.9)	145 (78.0)	I	I	I
	Yes	27 (29.1)	41 (22.0)	1.45 (0.82,2.55)*	1.94 (0.94,3.98)	0.074

Notes: I: Reference category. *Statistically significant at p-value<0.25, ^sStatistically significant at p-value <0.05.

Abbreviations: AOR, adjusted odds ratio; COR, crude odds ratio.

cough, lifting heavy objects, and alcohol consumption. A significant number of cases, 25 (26.9%) and controls, 54 (29.1%) of reported sleeping fewer than eight hours per day (Table 5).

Premature Rupture of Membrane (PROM)

Of the 93 cases of PROM Term, pre-term, and post-term PROM accounted for 55 (59.2%), 23 (24.7%), and 15 (16.1%), respectively.

Determinants of Premature Rupture of Membranes (PROM)

Out of 13 variables that were eligible for multivariable logistic regression, six variables, namely lack of ANC, previous history of abortion, previous history of PROM, caesarean delivery, maternal waiting room (MWR) utilization, and MAUC<23cm, were identified as significant determinants of PROM.

As a result, abortion history was found to be a significant predictor of PROM. The likelihood of

becoming a PROM case was 4.1 times higher among those respondents with a prior history of abortion than those who had not [AOR= 4.14; 95% CI: 1.7, 9.07]. Respondents who previously experienced a cesarean delivery had 3 times higher chance of becoming a PROM case than their counterparts [AOR= 3.02; 95% CI: 1.32, 6.40]. Lack of ANC was also identified as a risk factor for PROM in the current study. Those mothers with no ANC were 3.5 times more likely to develop a PROM than those respondents who got adequate ANC of 4 and more visits [AOR= 3.51; 95% CI: 1.39, 8.27]. Furthermore, women with a prior history of PROM had a 4.9-fold higher risk of developing PROM than their counterparts [AOR= 4.91; 95% CI: 2.23, 9.82]. When comparing respondents with MUAC ≥ 23 cm, those with MUAC < 23 cm were almost 3.7 times more likely to sustain PROM [AOR= 3.69; 95% CI: 1.65, 8.64]. During pregnancy, the use of the maternal waiting room (MWR) was found to be a major predictor of PROM. Women who stayed in the maternal waiting room during their current pregnancy were 67% less likely than their counterparts to get a PROM case [AOR= 0.33; 95% CI: 0.15, 0.74] (Table 6).

Discussion

This study aimed at finding out determinants of premature membrane rupture (PROM). Accordingly, lack of ANC, previous history of abortion, previous history of PROM, cesarean delivery, maternal waiting room (MWR) utilization, and MAUC < 23 cm were all identified as significant determinants of PROM.

The probability of being a PROM case was 3.4 times higher among respondents with a previous history of abortion than their counterparts, according to the results of this study. This finding is supported by studies conducted in Hyderabad, India, Lithuania, China and Uganda.^{36–38} The result was also supported by two studies conducted in Northern and Western Ethiopia.^{23,28} This may be justified by the fact that women with a history of abortion, especially if it was an unsafe abortion, are more likely to develop intra-amniotic and intrapartum infections, which may lead to PROM.³⁹ Furthermore, women who have had an abortion in the past, especially multiple abortions, are more likely to have a short cervix, which has been linked to an increased risk of PROM.^{2,40} As a result, health care providers must put a special emphasis on those mothers who have had prior abortions by providing health promotion during the ANC visit.

In line with previous studies conducted in Nigeria, India, Egypt, Bangladesh, and Sweden,^{20,41–44} this study also revealed that having a prior history of PROM is an important determinant for PROM. Women who had previously experienced PROM had 4.7 times higher chance of being a PROM case than women who have never even experienced PROM. This finding was also supported by studies conducted in Northern Ethiopia,^{22,28} Western Ethiopia.²³ This could be due to the possibility of having similar obstetric causes between the previous PROM event and the present PROM occurrence, such as an untreated genitourinary infection and a short cervical length (Cervical incompetence). Furthermore, obstetric conditions are by their very nature recurrent. Therefore, health care providers at maternal health service delivery points must emphasize assessing past obstetric problems, and once those mothers are identified, diligent evaluation, health promotion, and follow-up measures must be provided.

Besides, the current study established a lack of ANC as a determinant of PROM. Mothers who did not receive ANC were 3.63 times more likely to develop a PROM than those who received four or more visits of ANC. This finding is supported by the current studies conducted in India and Western Ethiopia.^{23,41} This may be explained by the fact that ANC is a significant touchpoint for pregnant women's overall wellbeing, as it facilitates the promotion and maintenance of the mother's health throughout her pregnancy. On the other hand, mothers who do not receive ANC may be less aware of the potential risk factors for PROM, and they may be exposed to risky activities and habits that increase the likelihood of PROM. As a result, health care providers must work to track all mothers who do not receive ANC, which may be a strategy for minimizing the burden of PROM.

In our study, having had a Caesarean section was also found to be a major risk factor. PROM was 3.16 times more common in women with a history of C/S than in women without a history of C/S. This result was in line with studies conducted in Uganda, Northern Ethiopia, and Western Ethiopia, which found that C/S was linked to PROM.^{23,28,45} This may be due to a higher risk of C/S scar rupture in subsequent pregnancies.¹ Despite the advantage of saving a woman's and newborn's lives, a cesarean section increases the risk of infection and uterine scarring, which might increase the likelihood of PROM.^{46,47} As a result, we recommend that health care

providers consider the potential risk of a Caesarean section and therefore only perform it when there are compelling clinical indications. To say it another way, to reduce the health risks associated with C/S, non-medical indications for C/S delivery should be reduced to the WHO-recommended standard (5–15%).⁴⁸

In the current study, those women with a Mid-Upper Arm Circumference (MUAC) of <23 cm had 3.79 times greater risk of developing PROM than those with a MUAC of ≥ 23 cm. A study conducted in Northern Ethiopia supplemented this finding.²² When the MUAC is less than 23 cm during pregnancy, it means that the mother is undernourished. Nutritional deficiencies, especially micronutrient deficiencies such as vitamin C or ascorbic acid, affect collagen formation and can impair the body's ability to defend itself from degenerative processes caused by oxidative stress, which could lead to easy breakage of the membrane.⁴⁹ Micronutrient deficiencies have been linked to an increased risk of PROM by disrupting collagen formation and structure.^{49,50} As a result, one of the most significant elements that health care providers should take is to strengthen nutritional counseling during prenatal care. Furthermore, maternal and child health care units must place a strong focus on screening and managing the nutritional status of pregnant women.

Another predictor that showed a significant relationship with PROM was the use of the maternal waiting room (MWR) during the current pregnancy. Women who stayed in the MWR during their current pregnancy had a 67% lower chance of becoming a PROM case than their counterparts. While there is little information on the relationship between this variable and PROM, some pieces of evidence showed that using MWR during pregnancy has a positive effect on maternal and child health by bridging the geographical accessibility gap.^{34,51} Furthermore, if a woman stays in an MWR during her final weeks of pregnancy, she may obtain sufficient rest and be less exposed to workload and heavy domestic activities, resulting in a lower risk of PROM and other maternal danger signs during pregnancy and childbirth. According to studies, MWR utilization decreased the likelihood of perinatal mortality and other social and economic effects for mothers by nearly half as compared to those who did not.^{52,53} As a result, government authorities in the study area should make an effort in favoring MWR for mothers who live a long distance away, as the majority of the study participants, 152 (54.5%), accessed health facilities after a one-hour or longer journey.

Although the reported cases were checked by senior doctors in the study hospitals, there may be misclassification bias. Another drawback of this study may be selection biases if some participants were unaware of when labor starts. The study included all women with PROM (preterm, term, and post-term) who were over 28 weeks of gestation, and there could be variations in determinants if the cases were separated for each category of PROM. Confounders were difficult to monitor because cases and controls were not matched with relevant variables since the study was unmatched case-control. The respondents might be prone to social desirability bias because some of the variables were based on self-reports. Finally, there might be a possibility of recall bias because women were asked about events that happened before the study.

Conclusion

In the current study, lack of ANC, previous history of abortion, previous history of PROM, caesarean delivery, maternal waiting room (MWR) utilization, and MAUC<23cm were identified as significant determinants of PROM. Hence, the stakeholders have to work on the provision of contraceptives to hamper the risks of abortion. Health-care providers should work on providing adequate ANC by tracing mothers who have not received it and advising pregnant women to use MWR in the final weeks of their pregnancy. Furthermore, maternal and child health care units must place a strong focus on screening and managing the nutritional status of pregnant women. Furthermore, women with a history of abortion, caesarean section, or PROM need extra attention from health care providers to mitigate the occurrence of PROM.

Abbreviations

ANC, antenatal care; AOR, adjusted odds ratio; CS, caesarean section; EDHS, Ethiopia demographic and health survey; MMR, maternal mortality ratio; MUAC, mid upper arm circumference; MWR, maternal waiting room; PROM, premature rupture of membranes.

Data Sharing Statement

The data used to strengthen the results of this study are to be had from the corresponding author based on reasonable request via the email address of akliluhabte57@gmail.com.

Ethics Approval and Consent to Participate

This study was approved and conducted per the principles of the Helsinki Declaration. Ethical clearance was obtained from the Institutional review board of Wolkite University, college of medicine and health sciences. The Zonal Health Departments and participating hospitals gave their written permission. Written informed consent was obtained from study participants aged 18 and older after they were briefed on the study's purpose and procedure. Furthermore, for those participants under the age of 18, consent was obtained from a parent or guardian via standard disclosure protocols. Participants' privacy and confidentiality were ensured before data collection. Their right not to participate, not to answer any or all questions, and to withdraw from the interview at any time they want was respected.

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Disclosure

The authors report no conflicts of interest in this work.

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