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Original Research

Perinatal and Early Neonatal Outcomes of Women With Premature Rupture of Membranes in Referral Health Care Facilities in the Ivory Coast: A Low-and Middle-Income Country

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Abstract

Background: The incidence of pregnancies with premature rupture of membranes (PROM) is between 1% and 10% worldwide. This study aimed to examine the perinatal and early neonatal outcomes in PROM in a reference healthcare maternity in a low- and middle-resource country of sub-Saharan Africa. **Methods**: A cross-sectional study with an analytical focus was conducted from 2019 to 2023, involving 789 PROM cases out of 22,570 deliveries, representing 3.5% of the total admissions. This study analyzed demographic data, obstetric history, prenatal care, and perinatal outcomes. Univariate and multivariate statistical analyses were performed to identify risk factors for maternal and neonatal complications. **Results**: The average age of the pregnant women was 32 years, with 76.7% aged between 20 and 40 years. The majority of births (62.9%) occurred between 28 and 34 weeks of gestation (WG), indicating a high prevalence of prematurity in the studied sample. Full-term births (>37 weeks) accounted for only 15.3%, indicating a concerning proportion of preterm deliveries. The majority of the women were unemployed (66.0%), and 40.7% had no formal education. An obstetric history of preterm premature rupture of membranes (PPROM) was reported in 57.4% of cases, and 16.7% had cervical incompetence. The median number of prenatal visits was 4 (range: 0–8). Neonatal mortality was 11.2%, with preterm infants accounting for 70.5% of the deaths. Delayed admission (>24 hours) and abnormal amniotic fluid (AF) were significantly associated with maternal infections ($p < 0.001$). The multivariate analysis revealed delayed admission [adjusted odds ratio (aOR): 19.82; $p < 0.001$] and abnormal AF (aOR: 4.38; $p < 0.001$) as strong predictors of maternal infections. For neonatal mortality, delays of more than 72 hours (aOR: 1.88; $p = 0.007$) and low birth weight (aOR: 42.55; $p < 0.001$) were also identified as risk factors. **Conclusions**: PROM is a common obstetric emergency associated with significant morbidity, limited resources, and socioeconomic challenges. This study highlights management gaps, emphasizing the need for improved prenatal care, early risk factor prevention, and the adaptation of strategies to local contexts to reduce complications.

Keywords: preterm; premature rupture of membranes; mortality and morbidity; prematurity; infection

1. Introduction

Commonly defined as loss of intra-amniotic fluid (AF) through the maternal genital tract, premature rupture of membranes (PROM) results from an opening of the membranes of an egg at any time during pregnancy, before the onset of uterine contractions [1,2]. Differentiating between the two types of PROM is possible, depending on the moment of onset during pregnancy: the preterm premature rupture of membranes (PPROM) occurs before 37 weeks of gestation (WG), whereas a term premature rupture of membranes (TPROM) occurs after 37 WG [1,2]. The frequency of the condition across all pregnancies is estimated to be between 1.0% and 10% worldwide [2–7], while in some African series the frequency ranges from 1% to 18% [8–11]. The majority of PROM cases occur beyond 37 WG [12]. Moreover, PROM is rarely observed before 28 weeks, representing 1 to 7/1000 pregnancies; however, a neonatal prognosis is extremely critical due to prematurity, infection, and pulmonary hypoplasia [12]. In low- and middle-income countries (LMICs), PROM is not easily diagnosed due to the lack of diagnostic tests [12–15]. Only clinical features can guide the diagnosis, often leading to errors, as these clinical elements are non-specific, and include the vulvar discharge aspects (spontaneous, abundant, permanent, clear, and odorless) as well as the visualization of a spontaneous or provoked liquid discharge of endocervical origin and/or in the posterior vaginal fornix. Furthermore, this diagnosis is often made when the amount of AF decreases on the ultrasound observation [16]; however, the possibility of false-negative results is noted, with an overestimation frequency of 12% [16,17].

Efficient management is crucial in preventing serious maternal and perinatal complications. However, this management requires a multidisciplinary medical team collaboration, alongside an individualized approach that consid-

ers gestational age, cervical condition, and fetal status. Additionally, this management strategy must be a continuous search for a suitable compromise between potential infectious risks and those related to prematurity [8]. All these aspects are challenging to implement in LMICs, where many health centers have inadequate technical equipment (including the absence of neonatal intensive care units) and unqualified human resources for neonatal resuscitation [17–19]. Furthermore, PROM is an important cause of perinatal morbidity and mortality. The main neonatal risks of PPROM are respiratory distress syndrome, sepsis, intraventricular hemorrhage, and death, which are related to prematurity in 24% to 42% [20], and require management in a well-equipped tertiary preventive healthcare [21]. Expectant management refers to the decision to allow the pregnancy to continue before 37^{+0} WG. The main risks are ascending infection and umbilical cord compression [22]. Premature delivery must always occur in a level 3 maternity hospital with a neonatal intensive care unit (NICU) [2,22]. However, LMICs face numerous difficulties that hinder the improvement of medical data [10,23]. In fact, LMICs continue to struggle with inadequate healthcare infrastructure, insufficient technical equipment, and a shortage of well-qualified healthcare providers, as well as the high cost of medical care, the lack of health insurance, and the unavailability of some treatments, such as synthetic surfactant [2,11–13]. All these factors make PROM management more difficult and further compromise early neonatal prognosis, with high morbidity and mortality rates [20,24–27]. A pregnant woman with PROM has a risk of intra-amniotic infection, postpartum infection, endometritis, and death [24,28]. Neonatal outcomes after expectant management are well described [26–28]. In contrast, limited research has addressed maternal outcomes associated with expectant management compared to the termination of pregnancy. Expectant management for PPROM before 24 WG was associated with a significantly higher risk of maternal morbidity when compared to TPROM. Thus, the maternal prognosis is related to the possible occurrence of some maternal complications, particularly infectious complications (sepsis and septic shock), which may result in mortality in 1% of cases [24], and an increase in morbidity of 58 to 63% [29–31].

Due to the lack of standard diagnostic methods, limited therapeutic options, and the scarcity of studies on prognostic factors in LMICs, this study aimed to evaluate the management and identify maternal and neonatal risk factors in a reference maternity unit.

2. Materials and Methods

We conducted a cross-sectional study with an analytical focus in a single tertiary perinatal center, from January 2019 to December 2023 (five years). Singleton or twin pregnancies with PROM that occurred after 28 WG or 6 months, including both PPROM and TPROM, were included. Pregnant women who delivered within 12 h after the onset of PROM, suspected urinary incontinence or physiological leukorrhea, or those with major fetal anomalies or fetal death in utero were not included.

Table 1. Sociodemographic characteristics of pregnant women.

Variables	Number (n = 789)	%
Age (years)		
<20	108	13.7
[20–30)	250	31.7
[30–40)	355	45.0
>40	76	9.6
Employment status		
None	521	66.0
Employed	268	34.0
Instruction level		
None	321	40.7
Primary	268	34.0
Secondary	125	15.8
Academic	75	9.5
Obstetric medical history		
PROM	453	57.4
Early spontaneous miscarriage	325	41.2
Preterm deliveries	231	29.3
CUI	132	16.7
Parity (number of deliveries)		
Primiparous (1)	448	56.8
Pauciparous (2–3)	254	32.2
Multiparous (>4)	87	11.0
Number of prenatal visits		
0	98	12.4
1	87	11.0
2–4	315	39.9
≥5	289	36.6

PROM, premature rupture of membranes; CUI, cervical uterine incompetence.

PROM diagnoses were suspected in the presence of a spontaneous vulvar discharge, clear, continuous, odorless, as well as the speculum visualization into the intracervical and/or vaginal fornix. This intracervical discharge was amplified by coughing, mobilization of the abdomen, and abdominal efforts in a pregnant woman with no uterine contractions or cervical changes. Due to the absence of diagnostic tests in Cote d'Ivoire, the PROM diagnosis was also suspected in the absence of fetal membranes on vaginal examination or the decrease in AF on ultrasound (amniotic fluid index [AFI] value of less than 25 cm). Pregnancies after 28 WG or 6 months, and before 37 WG, with clear spontaneous vulvar discharge without uterine contractions for more than 12 hours before the onset of labor, were also included in the study. We did not consider clear vulvar discharges that quickly dried up with normal AF on the ultrasound. An ultrasonography scan performed at admission evaluated fetal presentation and weight, as well as

Table 2. Clinical and obstetrical data.

Admission data	Number (n = 789)	%
Time between vaginal water loss and patient admission (h)		
<12	255	32.3
12–24	331	42.0
>24	203	25.7
Gestational age (WG)		
28–34 (PPROM)	496	62.9
35–37 (PPROM)	172	21.8
>37 (TPROM)	121	15.3
Macroscopic appearance of vulvar discharge		
Clear	502	63.6
Greenish	233	29.5
Bloody	54	6.8
Vulvar discharge smell		
Odorless	545	69.1
Foul-smelling	244	30.9
Diagnosis retained on admission		
PROM in labor	198	25.1
PROM not in labor	591	74.9
Obstetrical decision on admission		
Caesarean section	221	28.0
Vaginal delivery	233	29.5
Waiting and monitoring	335	42.5
Antenatal medical care		
Probabilistic antibiotic therapy	604	76.6
Antenatal betamethasone administration	676	85.7
Time between water loss and patient admission		
Short (<24 h)	123	15.6
Medium (24–72 h)	243	30.8
Long (>72 h)	423	53.6

WG, weeks of gestation; PPROM, preterm premature rupture of membranes; TPROM, term premature rupture of membranes.

AFI values. The maternal infectious assessment included a C-reactive protein (CRP) (used to assess inflammatory parameters, which were considered normal at values below 5 mg/L, and positive above 10 mg/L), and a white blood cell count was recorded every 3 days. Pregnant women received an intramuscular (IM) injection of corticosteroid or betamethasone at 12 mg, repeated 24 h later, to prevent hyaline membrane disease, as well as a beta-lactamase-stable broad-spectrum cephalosporin: ceftriaxone 2 g intravenous (IV) until birth. Infant outcomes included gestational age, birth weight, Apgar score at 5 minutes, neonatal transfer, hospital length of stay, neonatal outcomes (death or survival), respiratory distress, prematurity, and neonatal infection. Data were obtained from the medical records, delivery registers, operative reports, and maternal and neonatal death reports for the pregnant women. An anonymous questionnaire was used to collect the data. We selected all files recovered during the study period based on the inclusion and exclusion criteria. The parameters studied were sociodemographic characteristics, history, age of pregnancy, admission data (time of rupture, presence or absence of uterine contractions, vaginal bleeding, uterine height, fetal heartbeat, fetal presentation, diagnosis retained), time from water break to admission, obstetric decision, time from opening of membranes to delivery, mode of delivery, Apgar score at 5 minutes of life, birth weight, resuscitation of newborn, evacuation to neonatology, maternal–fetal complications. Fetal growth restriction (FGR) was defined as an estimated fetal weight (EFW) that was less than 1.5 standard deviations. Chorioamnionitis was suspected in the presence of a maternal body temperature >38 °C, tachycardia >70 bpm, uterine contractions, fetid vaginal discharge, and hyperleukocytosis at 15,000 elements/mm^3, as well as neutrophil counts >70%. The confidentiality of the information collected during the survey was guaranteed by assigning an anonymous number to each survey sheet. Data were analyzed using Epi Info software (Atlanta, GA, USA, version 3.5.1). Logistic regression analysis was used to identify maternal and neonatal prognostic factors associated with PROM. The statistical tests used were the chi-square

Table 3. Maternal paraclinical check-up and management.

Variables	Number (n = 789)	%
White blood cell count (elements/mm^3) outcomes	478	60.6
Hyperleukocytosis with neutrophiles polynuclear	233	48.7
C reactive protein test outcomes	360	45.6
Positive result (>5 mg/L)	193	53.6
Endocervical sampling outcomes	320	40.5
β-hemolytic Streptococcal Infections found	89	27.8
Cytological and bacteriological examination of urine outcomes	390	49.4
Escherichia coli found	89	22.8
Amount of AF on ultrasound (cm)	789	
Moderate decreased (15–25 cm)	302	38.3
Significant decreased (<15 cm)	487	61.7
Medical antenatal management cases	789	
Beta-lactamase antibiotic (ceftriaxone 2 mg)	594	75.3
Betamethasone acetate	546	69.2
Phloroglucinol injection ampoule	526	66.7
Nifedipine 20 mg injection ampoule	332	40.6
Time from water loss to delivery	789	
Short (<24 h)	76	9.6
Medium (24–72 h)	170	21.5
Long (>72 h)	543	68.8
Mode of delivery	789	
Vaginal delivery	287	36.4
Caesarean section	502	63.6

AF, amniotic fluid.

and the Student's *t*-test at a significance level of 5% or $p < 0.05$. Results are presented as the mean $\pm$ standard deviation (SD). A *p*-value of less than 0.25 at bivariate and 0.05 during multivariate logistic regression at a 95% confidence interval (CI) was considered statistically significant.

3. Results

3.1 Sociodemographic and Prenatal Monitoring Data

During this study, we recorded 22,570 admissions to the delivery room, including 789 cases of PROM, which corresponded to 3.5% of the deliveries. The average age of the pregnant women was 32 years, with extremes of 14 and 45 years. The predominant age group was between 20 and 40 years (76.7%), unemployed (66.0%), out of school (40.7%), with an obstetrical history of PROM (57.4%), and cervical incompetence (16.7%). The number of prenatal consultations varied between 0 and 8, with a median of 4. The data on the general characteristics of the pregnant women are highlighted in Table 1.

3.2 Clinical and Obstetrical Data

The median delay between rupture of membranes and admission was 34 hours, with extremes of 12 hours and 7 days (168 h). Patients were admitted between 12 and 24 hours after the rupture of membranes (42.0%). The mean gestation period was 36.53 weeks, with a standard deviation of 3.81. In 62.9% of the cases, the gestational age was between 6 months (28 WG) and 7 and a half months (34 WG). The vulvar and vaginal fluid appearance was clear (n = 502, 63.6%) and odorless (n = 545, 69.1%). A diagnosis of PROM was performed in 668 cases (84.7%), while the multidisciplinary decision to wait and monitor was conducted for 335 pregnant women (42.5%); meanwhile, a vaginal delivery was performed in 233 (29.5%) cases, and a caesarean section was employed in 221 (28.0%) cases (Table 2).

3.3 Maternal Paraclinical Check-up and Management

Maternal prenatal screening for PROM was not always performed due to a low economic level. In fact, analysis of the levels of the white blood cell count was conducted for 478/789 of the pregnant women (60.6%), CRP in 360/789 (45.6%), endocervical sampling for 320/789 (40.5%), and cytological and bacteriological examination of urine (CBEU) in 390/789 (49.4%). This maternal screening revealed an increased neutrophil count (48.7%), inflammation with a high positive CRP level (53.6%), the presence of beta-hemolytic streptococcus in the endocervical sampling (27.8%), and an *E. coli* infection in the CBEU analysis (22.8%). The amount of AF observed on the ultrasound indicated a significant decrease (<15 cm) (n = 487, 61.7%) (Table 3).

The antenatal medical care included the administration of broad-spectrum antibiotic prophylaxis (n = 594, 75.3%) and a double dose of 12 mg IM betamethasone ac-

Table 4. Neonatal and maternal prognosis outcomes.

Prognosis data	Number (n = 789)	%
Neonatal mortality data		
Neonatal death according to gestational age at delivery (WG)	88	
[28–34)	62	70.5
[34–37)	23	26.1
>37	3	3.4
Neonatal death according to delivery mode		
Vaginal birth	65	73.9
Caesarean section	23	26.1
Neonatal death according to infant birth weight		
1000–1500 g	54	23.7
1500–2000 g	21	15.7
2000–2500 g	9	25.0
2500–3000 g	3	31.1
>4000 g	1	4.6
Neonatal death with antenatal corticosteroid therapy	33	37.5
Neonatal death with lack of antenatal antibiotic prophylaxis	5	5.7
Global neonatal morbidity data	701	
Birth weight		
1000–1500 g	187	23.7
1500–2000 g	124	15.7
2000–2500 g	197	25.0
2500–3000 g	245	31.1
>4000 g	36	4.6
Neonatal Apgar score at 5 minutes	701	
[1–5) (poor)	223	31.8
[5–7) (medium)	311	44.4
Neonatal resuscitation	490	65.7
Reasons for neonatal transfer in neonatology unit		
Respiratory distress	368	49.3
Prematurity	668	89.5
Poor Apgar score at 5 minutes	223	31.8
Maternal morbidity data		
Infectious complications	420	53.2
Surgical site infection	231	55.0
Puerperal infection	180	42.8
Pelvic organ abscess	89	21.2
Peritonitis	34	8.1
Hysterectomy	24	3.1
Length of hospital stay (days)	789	
[1–2)	169	21.4
[2–10)	265	33.6
>10	355	45.0

etate (n = 546, 69.2%). The average time from water loss to consultation was 35 h, with extremes of 8 h and 360 h, while the average time from rupture of membranes to delivery was 8 days, with a range of 1 day to 176 days.

Caesarean delivery accounted for 36.4% of cases, with newborns weighing an average of 2707 g, with extremes of 1000 g and 4740 g. No multiple pregnancies were recorded alongside 88 cases of neonatal death (11.2%).

In Table 4, this study showed that 420 patients (53.2%) experienced infectious complications. The occurrence of these maternal complications led to hysterectomy in 24 patients (3.0%) and a prolonged hospital stay in 355 (45.0%), with an average hospital stay of 10 days (1 to 20 days).

3.4 Analytical Study of Factors Associated With Early Neonatal Prognosis

Table 5 highlights the comparative analysis of the factors contributing to the risk of maternal infectious complications in the presence of PROM. A statistically significant association was identified between lower maternal educational level (p = 0.027), a long delay exceeding 24 hours between fetal membrane rupture and hospital admission (p

Table 5. Univariate analysis of factors contributing to the occurrence of maternal infectious troubles (chi-square test).

Variables	Maternal infectious complications present		(χ^2)	*p*-value
	Yes (n = 420)	No (n = 369)		
Patient educational level				
Low (none and primary)	327 (77.9%)	262 (71.0%)	-	-
High (secondary and university)	93 (22.1%)	107 (29.0%)	-	-
			4.877	0.027
Time between PROM and admission >24 h				
Yes	367 (87.4%)	70 (19.0%)	-	-
No	53 (12.6%)	299 (81.0%)	-	-
			372.030	<0.001
Time from rupture of membranes to delivery >24 h				
Yes	397 (94.5%)	316 (85.6%)	-	-
No	23 (5.5%)	53 (14.4%)	-	-
			17.822	<0.001
Abnormal appearance of AF at patient admission				
Yes	322 (76.6%)	136 (36.9%)	-	-
No	98 (23.4%)	233 (63.1%)	-	-
			127.835	<0.001
Vaginal delivery				
Yes	255 (60.7%)	32 (8.7%)	-	-
No	165 (39.3%)	337 (91.3%)	-	-
			229.870	<0.001
Antibiotic prophylaxis administered				
Yes	250 (59.5%)	293 (69.8%)	-	-
No	170 (40.5%)	76 (30.2%)	-	-
			36.180	<0.001
Presence of hyperleukocytosis				
Yes	333 (79.3%)	315 (85.4%)	-	-
No	87 (20.7%)	54 (14.6%)	-	-
			4.950	0.026
CRP				
Positive	207 (49.3%)	182 (49.3%)	-	-
Negative	213 (50.7%)	187 (50.7%)	-	-
			0.000	0.992

CRP, c-reactive protein.

< 0.001), and a prolonged interval from fetal membrane rupture to delivery >24 hours ($p < 0.001$). In addition, an abnormal appearance of AF at admission was significantly associated with the occurrence of infections ($p < 0.001$), highlighting the potential of using AF as an early indicator of intra-amniotic infection. Vaginal delivery was also significantly more frequent among women with infectious complications ($p < 0.001$), which may reflect an increased risk of ascending infection with this mode of delivery in the context of membrane rupture. Interestingly, the administration of antibiotic prophylaxis was significantly less frequent in the group with infectious complications ($p < 0.001$), suggesting a critical role of timely and adequate antibiotic administration in preventing maternal infection. These results revealed no significant association for CRP between the two groups ($p = 0.992$), whereas the association with hyperleukocytosis, although statistically significant, was comparatively weaker ($p = 0.026$).

The analysis of the determinants of early neonatal death is shown in Table 6 and reveals numerous significant factors associated with a high risk of neonatal death, including long delays between water loss and patient admission of over 72 hours ($p = 0.007$), abnormal AF appearance (bloody and fetid; $p < 0.001$), gestational age at birth between 28 and 34 weeks ($p = 0.004$), and vaginal birth delivery ($p < 0.001$). The administration of antenatal betamethasone treatment significantly reduces the risk of early neonatal death ($p < 0.001$), suggesting a strong protective effect. In addition, low Apgar scores at 5 minutes were associated with early neonatal death, although the association was not statistically significant ($p = 0.057$). The existence of chorioamnionitis presented a very strong association with early neonatal death ($p < 0.001$), while low birth weight (<1500 grams) was also a significant risk factor for neonatal death ($p < 0.001$). These findings underscore the importance of addressing these factors to improve neonatal outcomes.

Table 6. Association of early neonatal death and clinical variables (chi-square test).

Variables	Early neonatal death		χ^2	*p*-value
	Yes (n = 88)	No (n = 701)		
Long delay between water loss and admission (>72 h)				
Yes	59 (67.0%)	364 (51.9%)	-	-
No	29 (33.0%)	337 (48.1%)	-	-
			7.187	0.007
Appearance of AF on admission				
Abnormal (bloody and fetid)	73 (85.1%)	211 (30.1%)	-	-
Normal	15 (14.9%)	490 (69.9%)	-	-
			94.806	<0.001
Gestational age at delivery (WG)				
28–34	62 (70.5%)	434 (61.9%)	-	-
34–37	23 (26.1%)	149 (21.3%)	-	-
>37	3 (3.4%)	118 (16.8%)	-	-
			10.949	0.004
Mode of delivery				
Vaginal birth delivery	65 (73.9%)	222 (31.7%)	-	-
Caesarean section	23 (26.1%)	479 (68.3%)	-	-
			60.146	<0.001
Antenatal betamethasone administration				
Yes	33 (37.5%)	571 (81.5%)	-	-
No	55 (62.5%)	130 (18.5%)	-	-
			84.156	<0.001
Low Apgar score at 5 minutes <5				
Yes	75 (85.2%)	534 (76.2%)	-	-
No	13 (14.8%)	167 (23.8%)	-	-
			3.637	0.057
Existence of chorioamnionitis				
Yes	53 (60.2%)	14 (2.0%)	-	-
No	35 (39.8%)	687 (98.0%)	-	-
			341.162	<0.001
Birth weight <1500 grams				
Yes	55 (60.5%)	12 (1.7%)	-	-
No	33 (39.5%)	689 (98.3%)	-	-
			371.795	<0.001

3.5 Multivariate Analysis

The multivariate analysis is presented in Table 7 and highlights the key risk factors associated with maternal infectious complications and early neonatal mortality. The significant predictors of maternal infections troubles were identified as educational level (adjusted odds ratio (aOR): 1.45, 95% confidence interval (CI): 1.03–2.06; $p = 0.035$), an interval >24 hours between fetal rupture opening and patient admission (aOR: 19.82, 95% CI: 13.72–28.62; $p < 0.001$), abnormal AF (aOR: 4.38, 95% CI: 3.07–6.25; $p < 0.001$), and vaginal delivery (aOR: 14.53, 95% CI: 9.47–22.29; $p < 0.001$). In contrast, the administration of antibiotics was shown to protect against the occurrence of these maternal complications (aOR: 0.64, 95% CI: 0.45–0.92; $p = 0.016$).

Many usual factors were shown to be related to an increased risk of early neonatal death, including an extended interval of >72 hours between PROM and patient admission (aOR: 1.88, 95% CI: 1.19–2.97; $p = 0.007$), bloody and fetid AF (aOR: 8.51, 95% CI: 4.73–15.31; $p < 0.001$), vaginal delivery (aOR: 3.27, 95% CI: 2.03–5.25; $p < 0.001$), lack of corticosteroids (aOR: 6.44, 95% CI: 3.85–10.78; $p < 0.001$), chorioamnionitis (aOR: 20.53, 95% CI: 10.31–40.93; $p < 0.001$), and low birth weight <1500 grams (aOR: 42.55, 95% CI: 18.84–96.08; $p < 0.001$).

4. Discussion

PROM remains a major challenge in obstetric care in Cote d'Ivoire, as in many other sub-Saharan African LMICs [5,8–10,21]. The complications observed from maternal and fetal infections are most often exacerbated by delayed consultation after the onset of PROM. However, antibiotics combined with antenatal corticosteroid therapy have proven to be effective in managing these complica-

Table 7. Multivariate analysis of maternal and early neonatal death prognosis risk factors.

Variables	Adjusted odds ratio (aOR)	95% confidence interval (CI)	*p*-value
Complications related to maternal infections			
Low educational level (none/primary)	1.45	1.03–2.06	0.035
Time between rupture of membranes and admission (>24 h)	19.82	13.72–28.62	<0.001
Time between rupture of membranes and delivery (>24 h)	2.22	1.17–4.20	0.014
Abnormal appearance of AF	4.38	3.07–6.25	<0.001
Vaginal delivery	14.53	9.47–22.29	<0.001
Antibiotic prophylaxis administered	0.64	0.45–0.92	0.016
Presence of hyperleukocytosis	0.72	0.51–1.01	0.059
Positive CRP	1.00	0.74–1.35	0.987
Early neonatal death			
Long time between water loss and admission (>72 h)	1.88	1.19–2.97	0.007
Abnormal appearance of AF	8.51	4.73–15.31	<0.001
Shorter gestational age (weeks)	1.45	0.85–2.47	0.170
Vaginal delivery	3.27	2.03–5.25	<0.001
Lack of antenatal corticosteroid administration	6.44	3.85–10.78	<0.001
Low Apgar score at 5 minutes (<5)	1.48	0.87–2.53	0.148
Presence of chorioamnionitis	20.53	10.31–40.93	<0.001
Birth weight <1500 grams	42.55	18.84–96.08	<0.001

tions, highlighting the essential role of antibiotics in patient care. This study offers valuable insights into the specific challenges encountered in managing PROM, particularly in the resource-limited settings of LMICs. This study also highlights existing gaps in research on managing PROM in Africa. Our analysis also highlights the importance of these findings for future research, underscoring the urgent need to develop care protocols that are more effectively tailored to local realities. Meanwhile, these findings also highlight the need to strengthen training for healthcare professionals and improve access to care, particularly in rural and underserved urban areas.

The frequency of PROM was relatively low in our study (3.5%). Despite this low rate, the occurrence of PROM should not be underestimated due to the numerous consequences of this condition for the mother and child. The global prevalence of PROM is estimated to be between 1.0 and 10% [2–7], while an African series reported rates ranging from 1% to 18% of pregnancies [5,8–10,21,28]. Our results corroborate those found in African and international literature, but also reveal specificities unique to the Ivorian context, influenced by socioeconomic, logistical, and health factors. This difference can be attributed to several factors, including the possibility of cases being underreported in our facilities due to a lack of systematic monitoring of pregnancies or late clinical diagnosis, potential exclusion of the earliest cases, and patients who were unable to access hospital care, as well as a preference for traditional or community-based care in certain areas, which limits the recording of cases in hospitals. The etiology of the disease remains poorly understood [22,32–34]; however, some authors have suggested risk factors such as low socioeconomic status, obstetric history of cervical incompetence, repeated spontaneous miscarriages, or previous PROM [1,4,7,9,27,32]. In our study, although some of these factors were present, their statistical significance was not always evident, which could be attributed to the lack of systematic screening (genital infections, cervical incompetence) during pregnancy and to limitations in the collection of gynecological and obstetric historical data, due to the lack of comprehensive medical records and missing data.

A high number of neonatal deaths was observed (11.2%) in our study. The main identified risk factors for morbidity and mortality were a delay in membrane rupture of >72 hours ($p < 0.001$) and a birth weight of <1500 g ($p < 0.001$).

Some contextual conditions in Cote d'Ivoire may explain the increased severity of these outcomes, including a shortage of neonatal resuscitation equipment, particularly in peripheral areas or primary care hospitals, the scarcity of fully functional NICUs, and the lack of continuing education for healthcare personnel in neonatal resuscitation. Similar results have been reported in the literature from many LMICs in Africa [12,13,26,27,29], as well as in India [32]. Prolonged membrane rupture exposes the fetus to several risks, including pulmonary hypoplasia and hyaline membrane disease. The consequences after birth include respiratory distress that requires care in a NICU, which is not always available in many LMICs [26,27]. Prolonged rupture also exposes the fetus to infections, which sometimes require neonatal resuscitation and prolonged hospitalization.

The benefits of antibiotic prophylaxis and corticosteroid therapy have been demonstrated in the literature [9,18]. However, the underuse of these therapies in our study (correlated with neonatal deaths) reflects the high cost of these drugs, which are most often paid for by the pa-

tients themselves because the medical centers/countries do not have social security, their frequent unavailability in hospital pharmacies, and the lack of standardized protocols that are accessible and applied in all hospitals in Cote d'Ivoire.

Most neonatal deaths were significantly associated with vaginal delivery ($p < 0.001$), absence of betamethasone administration to the mother ($p < 0.001$), and a low birth weight of less than 1500 g ($p < 0.001$). Similar observations have been reported in the literature for LMICs [1,3,11,12] compared to high-resource countries [4,8,14]. This might be explained by delayed decisions in performing a cesarean section in cases of fetal distress, inadequate management of labor in premature births, and the frequent lack of continuous monitoring of the fetal heart rate. Thus, improvements in healthcare infrastructure and equipment, expanded medical coverage, and public awareness campaigns could help reduce these perinatal mortality rates.

Among the maternal complications observed were intra-amniotic infections (chorioamnionitis), postpartum endometritis, and an increased frequency of cesarean sections. These complications have been widely described in previous studies [1,13,19,20,29]. Meanwhile, their impact on maternal morbidity may be exacerbated in Cote d'Ivoire by the lack of rapid biological diagnosis (CRP, blood cultures) due to the low purchasing power of the population, delays in surgical referral, especially in peripheral areas, and inadequate postpartum follow-ups, particularly after early discharge.

Furthermore, cases of PROM occurring before the threshold of fetal viability (<24 WG) pose a particular challenge in terms of maternal care. Studies by Dotters-Katz *et al*. [29] and Sklar *et al*. [30] reported high rates of maternal infection, sepsis, and prolonged hospitalizations in these situations, findings consistent with the high rates of early maternal complications observed in our study. These findings, observed in our series, highlight the unavailability of appropriate respiratory support and the lack of a clear national consensus on the management of extreme PROM in Cote d'Ivoire.

PROM is also associated with a higher rate of cesarean section, often due to fetal distress, non-cephalic presentation, or intrauterine infection [16,22,25]. While some guidelines recommend a wait-and-see approach to allow fetal maturation [15,32], others recommend early delivery in cases of infection [13,22]. Our data support the latter strategy, as the rate of cesarean sections was significantly higher in cases where signs of disease or fetal distress were observed.

Scholarly societies such as the American College of Obstetricians and Gynecologists (ACOG) and the Royal College of Obstetricians and Gynaecologists (RCOG) recommend individualized management strategies based on gestational age, clinical signs of infection, and fetal well-being [13,22,32]. However, the application of these strategies in Cote d'Ivoire is hindered by a lack of diagnostic tools (such as ultrasound and biological markers), a shortage of contextualized protocols available in health facilities, and unequal access to care between urban and rural areas.

Furthermore, in the context of other low-resource countries, implementing these recommendations remains difficult due to limited access to diagnostic tools and specialized obstetric care [9,23,28]. Therefore, maternal morbidity related to PROM remains a major concern in these settings. Finally, although certain biomarkers, such as CRP levels, have been proposed for the early diagnosis of intra-amniotic infections, the clinical utility of these biomarkers remains controversial [16]. In our context, the availability of tests to evaluate these biomarkers is often limited, which represents a potential area for improvement in maternal care.

Limitations

This study examined maternal and fetal outcomes of PROM and associated factors and has several limitations inherent in retrospective studies. This study lacked control groups with healthy pregnant women or non-PROM pregnant women, which prevented the distinction between PROM and non-PROM; thus, this study could not identify PROM-specific risk factors, such as delayed admission and low education level, which limits direct comparison and precise identification of associated factors. In addition, this study did not consider certain specific risk factors such as delayed admission, low level of education, obstetric history, socioeconomic conditions, undiagnosed genital infections, or limited access to prenatal care. The lack of long-term postnatal follow-up is also a limitation, as this absence prevents the assessment of long-term neonatal and maternal outcomes. Finally, the potentially monocentric or retrospective nature of the study may reduce the generalizability of the results to other contexts or populations.

5. Conclusions

PROM is common during pregnancy and remains a major obstetric emergency, associated with significant maternal and neonatal morbidity despite therapeutic advances. In our practice, we encounter numerous difficulties in management due to the high number of diagnostic errors, low levels of education, and limited income among families, as well as insufficient technical resources in our healthcare facilities. This study highlights gaps in the management of PROM, particularly in terms of late diagnosis and the lack of standardized protocols. These findings emphasize the importance of high-quality prenatal care and the early identification and prevention of risk factors. In low-resource settings, it is imperative to review management strategies and strengthen the capacity of the health system. Future research should focus on evaluating protocols adapted to local contexts and identifying socioeconomic factors influencing the management of PROM, with the ultimate goal of effectively reducing maternal and neonatal morbidity and mortality.

Availability of Data and Materials

Data supporting the results of this study are available from the corresponding author, but restrictions apply to their availability. The data were used under license for the current study, and are therefore not publicly available. However, the data are available from the authors upon reasonable request and with permission.

Author Contributions

Authors LNO, AKK, RK, JCB, GAZ, AY, DBM performed the research and contributed to data extraction and the manuscript draft. LNO, AKK, RK, DBM have made the analysis of data, manuscript revision, design and revision, final statistical analysis. All authors read and approve this final manuscript. All authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Felix Houphouet Boigny University (N347678-CI/2024). All subjects gave their informed consent for inclusion before they participated in the study.

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Conflict of Interest

The authors declare no conflict of interest.

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