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Outcome and Associated Factors of Abortion in Al-Sabeen Maternity and Childhood Hospital

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Abstract

Background: Spontaneous miscarriage is one of the global health concerns, and Yemen has one of the highest burdens in the region. This study aimed to determine the outcomes and associated factors of spontaneous miscarriage at Al-Sabeen Hospital in Sana'a City.
Methodology: A prospective case-control study was conducted over one year, involving 216 women with spontaneous miscarriage (cases) and 216 women with viable pregnancies beyond 24 weeks (controls). Data on sociodemographic characteristics, presenting symptoms, type of miscarriage, and obstetric, medical, and anatomical factors were collected through direct interviews and medical records. SPSS software was used for data analysis, and logistic regression was applied to test the correlation between potential risk factors and miscarriage.
Results: The mean age of cases was 28.4±6.1 years. Missed (36.1%) and incomplete miscarriages (31.0%) were the most common types. Univariate logistic regression identified several risk factors, including rural residency (cOR: 1.78, p=0.017), khat chewing (cOR: 1.48, p=0.043), history of abortion (cOR: 1.65, p=0.028), infections (cOR: 1.51, p=0.043), hyperprolactinemia (cOR: 7.99, p=0.001), and incompetent cervix (cOR: 36.03, p<0.001). In multivariable logistic regression, an incompetent cervix was identified as the strongest predictor of miscarriage (aOR: 29.167, P =0.001). Most mothers were managed and discharged without complications. However, some serious complications occurred, including 6.0% requiring blood transfusion and 3.7% requiring ICU admission for septic shock.
Conclusion: Spontaneous miscarriage in our sample is multifactorial and strongly linked to cervical incompetence and a history of previous miscarriage. Although maternal outcomes were generally good, some severe complications were documented, indicating the urgent need for enhanced preconception counseling, early antenatal screening for high-risk pregnancies, and improved access to emergency obstetric care in the region.

Article Info

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Miscarriage, Abortion, Spontaneous, Risk factors, Outcome, Incompetent cervix, Missed, Yemen.

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1. INTRODUCTION

Spontaneous miscarriage (spontaneous abortion) is defined as the non-induced loss of pregnancy before the fetus reaches viability. In contemporary clinical practice, this typically refers to pregnancy loss occurring before 20–24 weeks of gestation or the expulsion of an embryo or fetus weighing less than 500 g [1].

Spontaneous pregnancy loss is a common global health concern, affecting an estimated 10–20% of clinically recognized pregnancies, although the actual incidence is likely higher due to underreporting of early losses [1, 2]. Data from the Global Burden of Disease Study (2019) indicate approximately 42 million cases worldwide annually, with disparities influenced by geographic, socioeconomic, and demographic factors [2]. Regions with lower socioeconomic development indices (SDI) experience disproportionately higher rates, attributed to limited access to healthcare, nutritional defi-

ciencies, and environmental exposures [2, 3].

Recent regional data from the Middle East and North Africa (MENA) show that Yemen has one of the highest spontaneous miscarriage rates in this region. According to the Global Burden of Disease Study 2019, Yemen's age-standardized incidence rate of spontaneous abortion was 4794 per 100,000 people, significantly higher than the MENA regional average, which decreased from 5435 to 2410 per 100,000 people between 1990 and 2019 [4].

Yemen also has the highest spontaneous abortion-related death rate in the region, at 5.88 per 100,000 people, compared to an average regional death rate that fell from 4.51 to 0.48 per 100,000 people during the same period [4]. However, the Global Burden of Disease Study lacks data on specific maternal outcomes and the related risk factors for spontaneous miscarriage. Therefore, the present study aimed to determine the outcomes and associated factors of spontaneous miscarriage in women admitted to Al-Sabeen Hospital.

The health impact of spontaneous pregnancy loss is multifaceted and encompasses clinical, psychological, and social dimensions. Clinically, complications may include hemorrhage, hemodynamic instability, infection, or retained products of conception requiring medical intervention such as uterine evacuation or pharmacological management [5]. However, the psychological sequelae often pose a greater burden, with individuals frequently experiencing grief, anxiety, depression, and post-traumatic stress, which can persist long-term and affect overall well-being [6]. Socially, stigma and inadequate support systems may exacerbate distress, particularly in settings where reproductive loss is stigmatized [7].

Spontaneous miscarriage is not a singular event but a process that is clinically classified into distinct stages based on presentation. These include biochemical pregnancy loss, detected only by declining hCG levels before ultrasound visibility, and missed miscarriage, where non-viable pregnancy tissue is retained without symptoms. A threatened miscarriage involves bleeding with a closed cervix and a viable pregnancy, whereas an inevitable miscarriage features an open cervix, signaling an imminent expulsion. An incomplete miscarriage involves the partial passage of tissue, often requiring intervention, whereas a complete miscarriage is confirmed when all products of conception are expelled and the uterus is empty. Recurrent pregnancy loss (RPL), defined as two or more losses, affects 1-2% of women and has diverse etiologies, including genetic, anatomical, and immunological factors, although half of the cases remain unexplained. In addition, a septic miscarriage is a severe intrauterine infection following any stage of miscarriage, typically requiring emergency care [1, 8].

The etiology and risk factors for miscarriage are complex and multifactorial in nature. Chromosomal abnormalities are the leading cause, responsible for 50-65% of first-trimester losses, with the risk of aneuploidy rising from approximately 30% in women aged 35 to over 80% in women over 40 [9]. Advanced maternal age itself dramatically increases miscarriage rates, from 9-17% at age 20-30, to 20% at 35, 40% at 40, and up to 80% by age 45 [5]. A history of prior pregnancy loss is another independent risk factor, with recurrence risk increasing from approximately 20% after one miscarriage, to 28% after two, and 43% after three or more [5]. Maternal health conditions significantly contribute: uterine anomalies are present in 10-15% of women with RPL, and endocrine disorders like poorly controlled diabetes can double to quadruple the risk [1, 10]. The presence of antiphospholipid antibodies is a key treatable immune cause [8], while lifestyle factors also play a role, with cigarette smoking and heavy alcohol consumption ($\geq$5 drinks per week) associated with a 2- to 4-fold increased risk [11, 12]]. Obesity (BMI $\geq$30 kg/m^2) increases the odds by approximately two times [13]. Thus, miscarriage typically results from the interplay of genetic, anatomical, endocrine, immunological, and environmental pathways.

2. MATERIALS AND METHODS

Study design, participants, and setting

From September 2024 to August 2025, a prospective case–control study was conducted at Al-Sabeen Hospital among pregnant women who experienced miscarriage before 24 weeks' gestation. Patients with induced abortion, stillbirth, or pregnancy loss after 24 weeks of gestation were excluded. The control group consisted of age-matched women who were pregnant beyond 24 weeks without any signs of miscarriage and attended obstetric clinics for routine antenatal care. The sample size for this case-control study was calculated using Epi Info version 7, and the final sample consisted of 216 cases and 216 controls.

Study tool and data collection

For data collection, a pre-designed questionnaire was prepared according to the study objectives. It included demographic and obstetric variables, clinical presentation, and potential risk factors (general, anatomical, and autoimmune factors). To ensure that the questions aligned with the study purpose, the questionnaire was validated by the obstetrics and gynecology department at Sana'a University. The final version of the questionnaire was in English. However, the researcher used simple local Arabic during the interviews with the patients. To assess the clarity and simplicity of the questions, 20 cases were interviewed at the beginning as a pilot sample, and this number was included in the final sample. Variables such as trauma, psychological disturbances, chronic re-

nal disease, and family history of congenital anomalies were recorded based on the patient history obtained through direct interviews. In contrast, variables including TORCH infection, hyperprolactinemia, thyroid dysfunction, pregnancy-induced toxemia (PET), and antiphospholipid antibody syndrome were documented based on available clinical records, clinical evaluation, and relevant laboratory investigations. In some cases, initial external ultrasound documentation was incomplete or non-standardized at presentation. However, the final diagnosis and case classification in this study were based on in-hospital clinical assessment, including confirmatory pelvic ultrasonography as part of routine diagnostic practice. Data anonymity was preserved.

Case definition

A case of spontaneous miscarriage was defined as any loss of pregnancy occurring at $\leq$24 weeks from the last menstrual period, which was not induced by the patient or any other person. In this study, the term "abortion" refers only to spontaneous abortion (i.e., miscarriage). Cases of induced abortion were excluded. The final diagnosis and case classification in this study were based on in-hospital clinical assessment, including clinical findings, pelvic ultrasonography, and β-HCG monitoring, where indicated. We considered 24 weeks as a cutoff point because this point is more accepted in our locale and it aligns with practices in some countries [14].

Data analysis

Data were analyzed using IBM SPSS Statistics version 27 (IBM Corp., Armonk, NY, USA). Variables were described using frequencies and percentages. Tables and graphs were used to display the data. Chi-square or Fisher's exact test was used to test the association between miscarriage and other variables. Logistic regression analysis was used to identify the potential risk factors associated with miscarriage. The test was considered significant if the p-value was < 0.05.

3. RESULTS

Demographic and obstetric characteristics of the cases

Of the 216 cases, the highest rate (31.5%) was within the 20–25-year age group, while the lowest rate was <20 years (10.6%), as shown in Figure (1). As shown in Table (1), most cases resided in urban areas (75%, Sana'a city), about half (52.8%) reported khat chewing, 20.4% were illiterate, while 45.4% could read and write, 44% were gravida 2 to 4, and miscarriage occurred in 23.6% of their last pregnancies. The history of previous miscarriages was positive in 46.3% of the patients (Figure 2).

Characteristics of the current miscarriage

The results in Table1 reveal that the current miscarriage occurred mainly between 5 and 12 weeks (56.9%). Patients commonly present with vaginal bleeding, abdominal pain, and back pain.

The final diagnosis and classification (type of miscarriage) were based on obstetric history, clinical examination findings, and confirmatory ultrasound findings. As demonstrated in Figure 1, the common types of diagnosed miscarriage were missed, incomplete, threatened, and complete miscarriages at rates of 36.1%, 31%, 11.6%, and 10.2%, respectively.

Maternal outcome

As shown in Figure 4, most patients (59.7%) were discharged in good condition after undergoing uterine evacuation, 17.1% were managed with an expectant approach and scheduled for follow-up in the outpatient clinic, and 8.3% required admission to the department for medical management and observation. More serious complications were also observed, with 6.0% of patients needing a blood transfusion and 3.7% requiring admission to the ICU due to septic shock and hemodynamic instability.

Comparing cases and controls according to general characteristics

Comparing the general characteristics between the cases and controls revealed several significant differences, as shown in Table 3. Cases had a significantly higher proportion of rural residents (25.0% vs. 15.7% for controls; p=0.017) and reported a higher prevalence of khat chewing (52.8% vs. 43.1%; p=0.043). A trend towards a higher prevalence of smoking was found in the case group (22.7% vs. 16.2%), though this difference was not statistically significant (p=0.089).

Gravidity distribution showed a statistically significant variation (p=0.001), with cases demonstrating lower proportions of primigravida women (18.5% vs. 34.3% in controls) and higher proportions of multigravida women (37.5% vs. 30.1% for gravida $>$4). Parity also differed significantly (p=0.005), as cases had fewer nulliparous women (24.5% vs. 38.4%) but higher proportions of multiparous women (13.0% vs. 7.9% for para $>$4). Most notably, a history of previous abortion was significantly more common among cases (46.3%) than among controls (29.2%, p$<$0.001). No significant differences were observed between the other variables.

Comparing cases and controls according to chronic medical conditions

As shown in Table 4 cases showed a significantly higher prevalence of history of infectious diseases (38.9% vs.

Table 1. Demographic and obstetric characteristics of the cases

Variable	Category	Count (n=216)	Percent
Residency region	Urban (in Sana'a city)	162	75.0%
	Rural (outside Sana'a)	54	25.0%
Special habits	Smoking	49	22.7%
	Khat chewing	114	52.8%
	None	53	24.5%
Education of women	None	44	20.4%
	Read & write	98	45.4%
	High school	74	34.2%
Occupation of women	Housewife	206	95.4%
	Employee	10	4.6%
Education of husbands	None	21	9.7%
	Read & write	96	44.4%
	High school	99	45.9%
Working status of husband	Working	122	56.5%
	Not working	94	43.5%
Gravidity	Gravida 1	40	18.5%
	Gravida 2-4	95	44.0%
	Gravida >4	81	37.5%
Parity	Para 0	53	24.5%
	Para 1-4	135	62.5%
	Para >4	28	13.0%
Results of the last pregnancy	Term delivery	102	47.2%
	Miscarriage	51	23.6%
	Preterm delivery	19	8.8%
	Vesicular mole	2	0.9%
	Ectopic pregnancy	2	0.9%
	Not applicable (primigravida)	40	18.6%

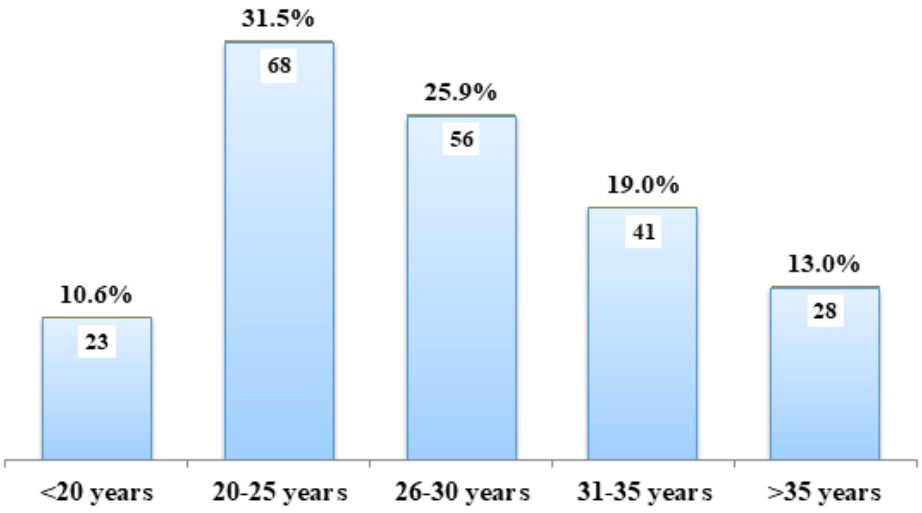

Figure 1. Distribution of cases according to the age.

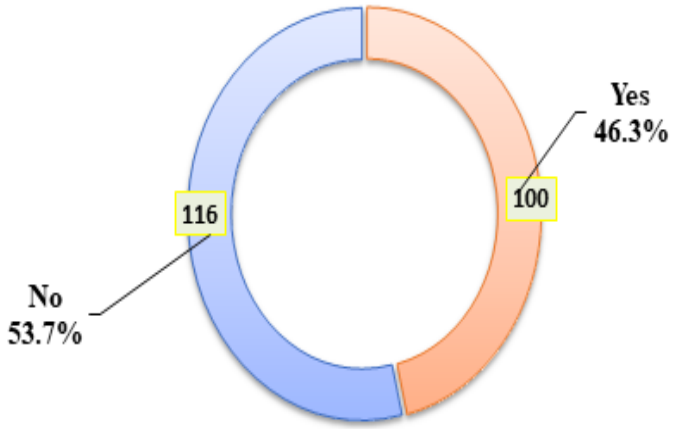

Figure 2. Distribution of cases according to the history of previous miscarriage.

Table 2. Characteristics of the current miscarriage

Variable	Category	Count (n=216)	Percent
Gestational age at onset of current miscarriage	5 -12 weeks	123	56.9%
	13-20 weeks	54	25.0%
	21-24 weeks	39	18.1%
Clinical presentation*	Vaginal bleeding	167	77.3%
	Abdominal pain	138	63.9%
	Back Pain	124	57.4%
	Regression of pregnancy symptoms	57	26.4%
	Shock	25	11.6%
	Passage of fetal tissue	10	4.6%

*Multiple response variables.

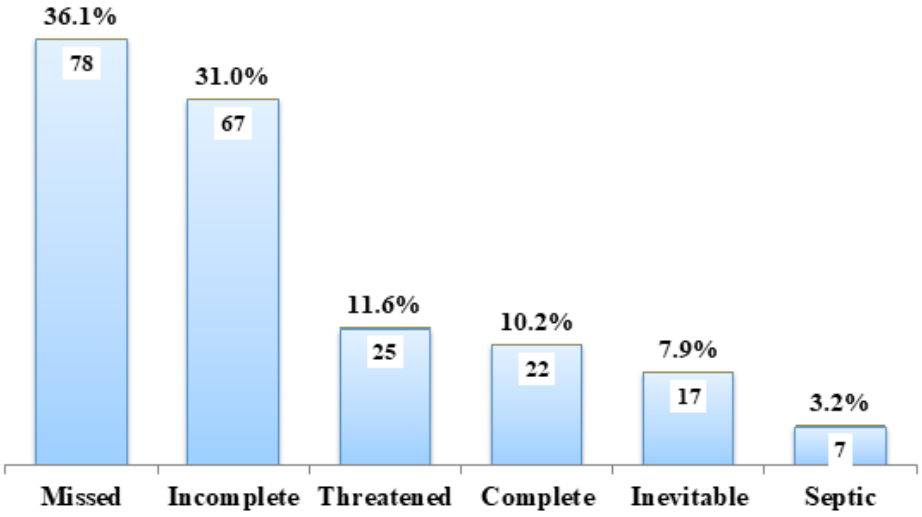

Figure 3. Final diagnosis (types of current miscarriage).

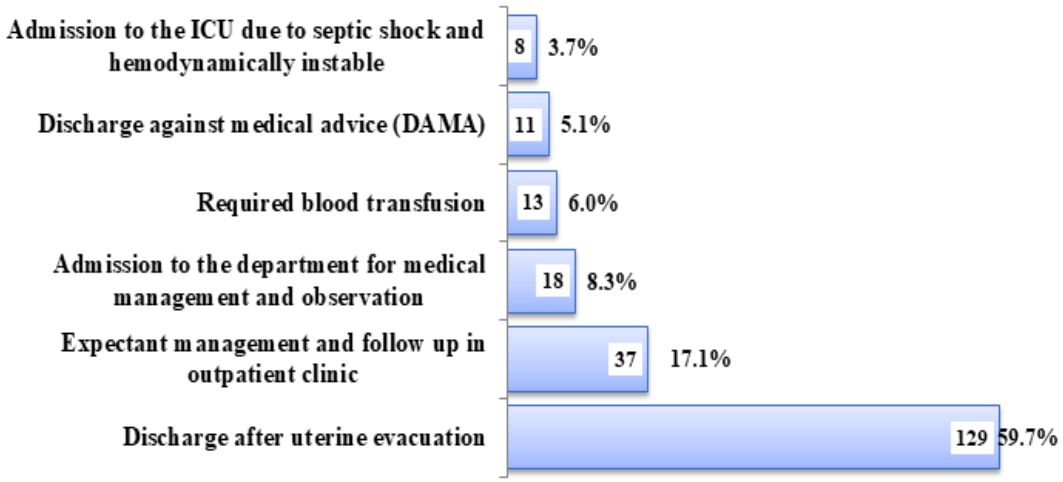

Figure 4. Maternal outcome of the studied cases.

Table 3. Comparing cases and controls according to general characteristics

Variable	Category	Cases (n=216)	Controls (n=216)	P value
Age of mothers	<20 years	23 (10.6%)	20 (9.3%)	0.278
	20-25 years	68 (31.5%)	86 (39.8%)	
	26-30 years	56 (25.9%)	59 (27.3%)	
	31-35 years	41 (19.0%)	30 (13.9%)	
	>35 years	28 (13.0%)	21 (9.7%)	
Residency region	Urban	162 (75.0%)	182 (84.3%)	0.017
	Rural	54 (25.0%)	34 (15.7%)	
Smoking	Yes	49 (22.7%)	35 (16.2%)	0.089
	No	167 (77.3%)	181 (83.8%)	
Khat chewing	Yes	114 (52.8%)	93 (43.1%)	0.043
	No	102 (47.2%)	123 (56.9%)	
Education of women	None	44 (20.4%)	30 (13.9%)	0.186
	Read & write	98 (45.4%)	102 (47.2%)	
	High school	74 (34.3%)	84 (38.9%)	
Working status of women	Housewife	206 (95.4%)	210 (97.2%)	0.308
	Employee	10 (4.6%)	6 (2.8%)	
Education of husbands	None	21 (9.7%)	17 (7.9%)	0.702
	Read & write	96 (44.4%)	93 (43.1%)	
	High school	99 (45.8%)	106 (49.1%)	
Working status of husbands	Working	122 (56.5%)	139 (64.4%)	0.094
	Not working	94 (43.5%)	77 (35.6%)	
Gravidity	Gravida 1	40 (18.5%)	74 (34.3%)	0.001
	Gravida 2-4	95 (44.0%)	77 (35.6%)	
	Gravida >4	81 (37.5%)	65 (30.1%)	
Parity	Para 0	53 (24.5%)	83 (38.4%)	0.005
	Para 1-4	135 (62.5%)	116 (53.7%)	
	Para >4	28 (13.0%)	17 (7.9%)	
Previous miscarriage	Yes	100 (46.3%)	63 (29.2%)	<0.001
	No	116 (53.7%)	153 (70.8%)	

Chi-square test was applied.

Table 4. Comparing cases and controls according to chronic medical conditions

Condition	Cases (n=216)	Controls (n=216)	P value
Infectious disease (malaria, UTI, chest infection)	84 (38.9%)	64 (29.6%)	0.043
Fever	63 (29.2%)	40 (18.5%)	0.009
Medications (Quinine, Misoprostol, Cytotoxic)	23 (10.6%)	18 (8.3%)	0.412
Hyperprolactinemia	15 (6.9%)	2 (0.9%)	0.001
Chronic renal disease	13 (6.0%)	6 (2.8%)	0.100
Trauma	21 (9.7%)	10 (4.6%)	0.040
Psychological disturbances	11 (5.1%)	1 (0.5%)	0.003
Family history of congenital anomalies	10 (4.6%)	9 (4.2%)	0.814
Hypertension	16 (7.4%)	8 (3.7%)	0.093
TORCH infection	10 (4.6%)	2 (0.9%)	0.019
Uncontrolled DM	6 (2.8%)	3 (1.4%)	0.503*
Thyroid disorders	6 (2.8%)	3 (1.4%)	0.503*
PET	9 (4.2%)	1 (0.5%)	0.010
Chronic liver disease	2 (0.9%)	1 (0.5%)	1.000*
Anti-phospholipid Ab syndrome	5 (2.3%)	2 (0.9%)	0.449*
SLE	3 (1.4%)	0	0.248*
Autoimmune hepatitis	1 (0.5%)	0	1.000*

Chi-square test was applied except in items labeled (*) where Fisher's exact test was used.

29.6%; p=0.043), fever (29.2% vs. 18.5%; p=0.009), and trauma (9.7% vs. 4.6%; p=0.040). Notably, the prevalence of hyperprolactinemia was markedly higher in the case group (6.9% vs. 0.9%; p=0.001). Similarly, significant differences were found in psychological disturbances (5.1% vs. 0.5%; p=0.003), TORCH infection (4.6% vs. 0.9%; p=0.019), and pre-eclampsia (PET) (4.2% vs. 0.5%; p=0.010). No statistically significant differences were observed between the other variables.

Comparing cases and controls according to anatomical risk factors

As shown in Table 5, a significantly higher prevalence of incompetent cervix was observed among cases than among controls (14.4% vs. 0.5%; p<0.001). Similarly, uterine hypoplasia was significantly more common in the case group (8.3% vs. 2.3%; p=0.005).

Regression analysis for potential factors associated with miscarriage

As shown in Table 6, univariate logistic regression identified rural residency (cOR 1.78, P=0.018), khat chewing (cOR 1.48, P=0.043), multigravidity (G2–4: cOR 2.28, P=0.001; G>4: cOR 2.31, P=0.001), parity (P1–4: cOR 1.82, P=0.006; P>4: cOR 2.58, P=0.007), prior miscarriage (cOR 1.65, P=0.028), infectious disease (cOR 1.51, P=0.043), fever (cOR 1.81, P=0.010), hyperprolactinemia (cOR 7.99, P=0.006), trauma (cOR 2.22, P=0.045), psychological disorders (cOR 11.54, P=0.020), TORCH infection (cOR 5.19, P=0.035), PET (cOR 9.35, P=0.035), incompetent cervix (cOR 36.03, P<0.001), and uterine hypoplasia (cOR 3.84, P=0.009) as significant correlates of miscarriage.

In the multivariable model (Table 7), rural residence (aOR 1.72, P=0.048), prior miscarriage (aOR 1.87, P=0.039), hyperprolactinemia (aOR 6.30, P=0.020), psychological disorders (aOR 10.59, P=0.029), and incompetent cervix (aOR 29.167, P=0.001) remained independent predictors of miscarriage.

DISCUSSION

Comparing the demographic characteristics between the cases and controls revealed significant differences. Although the distribution of maternal age did not reach statistical significance between the cases and controls (p=0.278), a notable trend towards a higher proportion of cases was observed in the older age categories (31-35 years: 19.0% vs. 13.9%; >35 years: 13.0% vs. 9.7%). This pattern is consistent with a large body of literature

Table 5. Comparing cases and controls according to anatomical risk factors

Condition	Cases (n=216)	Controls (n=216)	P value
Incompetent cervix	31 (14.4%)	1 (0.5%)	<0.001
Uterine hypoplasia	18 (8.3%)	5 (2.3%)	0.005
Endometriosis	3 (1.4%)	0	0.248*
Endometrial polyps	7 (3.2%)	2 (0.9%)	0.175*
Uterine malformation	5 (2.3%)	0	0.061*
Asherman syndrome	2 (0.9%)	1 (0.5%)	1.000*
Uterine mass	3 (1.4%)	1 (0.5%)	0.623*

Chi-square test was applied except in items labeled (*) where Fisher's exact test was used.

Table 6. Univariate logistic regression analysis for potential factors of miscarriage

Factor	Category	Wald	cOR	95% CI	P value
Age (ref: <20 years)	20-25 years	1.171	0.688	0.349-1.355	0.279
	26-30 years	0.287	0.825	0.409-1.665	0.592
	31-35 years	0.197	1.188	0.555-2.547	0.657
	>35 years	0.124	1.159	0.509-2.643	0.725
Resident region (ref: urban)	Rural	5.626	1.784	1.106-2.879	0.018
Smoking (ref: No)	Yes	2.874	1.517	0.937-2.457	0.090
Khat chewing (ref: No)	Yes	4.077	1.478	1.012-2.160	0.043
Gravidity (ref: Gravida 1)	Gravida 2-4	10.980	2.282	1.401–3.719	0.001
	Gravida >4	10.531	2.305	1.392–3.818	0.001
Parity (ref: Para 0)	Para 1-4	7.675	1.823	1.192–2.787	0.006
	Para >4	7.157	2.579	1.288–5.164	0.007
Previous miscarriage (ref: No)	Yes	4.851	1.650	1.057–2.576	0.028
Infectious disease (ref: No)	Yes	4.092	1.511	1.013-2.255	0.043
Fever (ref: No)	Yes	6.653	1.812	1.153–2.846	0.010
Medications (ref: No)	Yes	0.671	1.311	0.686-2.506	0.413
Hyperprolactinemia (ref: No)	Yes	7.490	7.985	1.803–35.357	0.006
Renal disease (ref: No)	Yes	2.572	2.241	.836-6.010	0.109
Trauma (ref: No)	Yes	4.025	2.218	1.019-4.830	0.045
Family history of cong. anomalies (ref: No)	Yes	0.055	1.117	0.445-2.804	0.815
Psychological disorders (ref: No)	Yes	5.435	11.537	1.476–90.158	0.020
Hypertension (ref: No)	Yes	2.718	2.080	0.871-4.968	0.099
TORCH (ref: No)	Yes	4.453	5.194	1.125–23.992	0.035
Diabetes (ref: No)	Yes	0.982	2.029	0.501-8.218	0.322
Thyroid disease (ref: No)	Yes	0.982	2.029	0.501-8.218	0.322
PET (ref: No)	Yes	4.458	9.348	1.174–74.435	0.035
Incompetent cervix (ref: No)	Yes	12.325	36.027	4.871–266.473	<0.001
Uterine hypoplasia (ref: No)	Yes	6.813	3.836	1.398–10.529	0.009

Table 7. Multivariable logistic regression analysis for potential factors of miscarriage

Factor	Category	Wald	aOR	95% CI	P value
Resident region (ref: urban)	Rural	3.895	1.718	1.004-2.942	0.048
Smoking (ref: No)	Yes	1.776	1.467	0.835-2.576	0.183
Khat chewing (ref: No)	Yes	0.929	1.256	0.790-1.997	0.335
Gravidity (ref: Gravida 1)	Gravida 2-4	0.004	0.960	0.279-3.311	0.949
	Gravida >4	0.435	0.603	0.134-2.711	0.510
Parity (ref: Para 0)	Para 1-4	0.589	1.570	0.496-4.973	0.443
	Para >4	1.249	2.287	0.536-9.756	0.264
Previous miscarriage (ref: No)	Yes	4.267	1.874	1.033-3.400	0.039
Infectious disease (ref: No)	Yes	0.149	1.107	0.659-1.860	0.700
Fever (ref: No)	Yes	0.589	1.260	0.698-2.275	0.443
Hyperprolactinemia (ref: No)	Yes	5.383	6.300	1.331-29.825	0.020
Renal disease (ref: No)	Yes	2.947	2.544	0.876-7.388	0.086
Trauma (ref: No)	Yes	0.200	1.237	0.487-3.143	0.655
Psychological disorders (ref: No)	Yes	4.738	10.588	1.265-88.622	0.029
Hypertension (ref: No)	Yes	3.692	2.550	0.981-6.625	0.055
TORCH (ref: No)	Yes	2.668	3.827	0.765-19.159	0.102
PET (ref: No)	Yes	0.733	2.708	0.277-26.501	0.392
Incompetent cervix (ref: No)	Yes	10.550	29.167	3.810-223.276	0.001
Uterine hypoplasia (ref: No)	Yes	1.682	2.133	0.679-6.706	0.195

confirming advanced maternal age as a risk factor for pregnancy loss, which may be attributed to factors such as declining oocyte quality, increased congenital anomalies, and increased prevalence of uterine pathologies [15, 16].

The results revealed that maternal rural residence was more common among cases, a pattern that may reflect differential access to prenatal surveillance and health infrastructure rather than geographic location alone [17, 18]. Similarly, khat consumption was observed more frequently in the case group, which aligns with the proposed biological mechanisms involving cathinone-induced vasoconstriction and altered placental physiology [19]. Although tobacco use did not differ statistically between the groups, the higher rate of smoking among the cases remains noteworthy, which is consistent with the literature linking smoking-related hypoxia to early pregnancy disruption [20, 21].

The distribution of gestational age at the onset of miscarriage in the current study demonstrated a predominant occurrence in the first trimester, with 56.9% of cases occurring between 5 and 12 weeks of gestation, which is consistent with epidemiological data identifying this period as the highest risk period for pregnancy loss [22, 23].

The obstetric profile of the current study appeared to be associated with miscarriage. The markedly lower proportion of primigravid women among the cases than among the controls and the correspondingly higher rate of high gravidity indicate that the risk of pregnancy loss increases with an increasing number of pregnancies. A history of miscarriage was a powerful predictor even after adjustment of odds, which aligns with a large prospective cohort study that found that a history of prior miscarriage was an independent risk factor for subsequent repeat miscarriage [24].

The comorbidity profile observed in the cases suggests that systemic infection and febrile illness may act as potent risk factors for miscarriage, likely through inflammatory cascades and direct placental insult [25]. The noted association with hyperprolactinemia raises the possibility of endocrine disruption affecting luteal phase support and implantation integrity [26]. Additional findings related to trauma, psychological distress, TORCH exposure, and pre-eclampsia further suggest the multifactorial nature of the disease [8, 26].

The present study highlights the critical role of structural abnormalities in the etiology of pregnancy loss. Incompetent cervix, present in 14.4% of cases, was identified as the single strongest risk factor for miscarriage. Cervical insufficiency is a well-recognized cause of recurrent second-trimester miscarriage and extreme preterm birth, with an incidence estimated at approximately 1% of all pregnancies but accounting for up to 20% of mid-

trimester losses [27, 28]. The high crude and adjusted odds ratios observed in this cohort suggest a strong association between cervical incompetence and miscarriage. This often leads to rapid, painless cervical dilation and fetal expulsion [29].

The present study reported a missed miscarriage rate of 36.1%, which is comparable to regional findings from Saudi Arabia (31.8–34.2%) [30, 31], and consistent with the increasing trend observed in Finland (30.3–38.8%) [32], though higher than the commonly reported global rate of 10–20% for missed miscarriage [18]. The 31.0% rate of incomplete miscarriage in this study positions it within the spectrum of regional reports, being proximate to 22.7% and 35.1% reported by Al-Khify et al. and Othman, respectively [30, 31], and higher than 19.7% reported by Alghamdi et al. [33].

In this study, the complete miscarriage rate of 10.2% was notably lower than the 22.3% reported by Al-Khify et al. [30] but higher than the 2.7% reported by Alghamdi et al. [33]. This lower frequency in hospital-based studies is a common finding, likely reflecting that cases of complete miscarriage often do not present to a healthcare facility, leading to an underestimation of the true community prevalence. The current study found a threatened miscarriage rate of 11.6%, which is lower than the 25.7% reported by Alghamdi et al. [33]. Conversely, the proportion of inevitable miscarriages was 7.9%, slightly higher than the 4.6% reported in the same prior study [33]. The current study found a 3.2% prevalence of septic miscarriage. This rate is notably higher than the 2.3% reported by Alghamdi et al. [33], underscoring a significant public health concern.

More concerning were the rates of severe complications, which affected a subset of the study sample. The 3.7% admission rate to the Intensive Care Unit (ICU) due to septic shock and hemodynamic instability is a significant finding. While maternal sepsis accounts for a variable percentage of ICU admissions globally, ranging from 1.1% to 25% across studies [34], the 3.7% rate in this study highlights the persistent danger of septic miscarriage, a condition that carries a high fatality rate, especially when progressing to septic shock [35]. The 5.1% of patients who left against medical advice (DAMA) is also a critical outcome, potentially leading to poorer health outcomes and under-reporting of complications. This can be attributed to economic barriers.

4. STUDY STRENGTHS & LIMITATIONS

The primary strength of this study is its prospective case-control design, which provides clear case definitions and a comprehensive analysis of demographic, obstetric, medical, anatomical, and autoimmune risk factors relevant to the Yemeni population. A limitation of this study was the incomplete availability of some initial external ultrasound reports for referred cases. However, the final diagnosis and case classification were based on complete in-hospital clinical assessment, including confirmatory pelvic ultrasonography as part of routine diagnostic practice. Additionally, limitations include potential residual confounding from unmeasured variables such as genetics, clotting disorders, pre-pregnancy BMI, environmental exposure, and detailed nutritional status. Rare conditions (e.g., autoimmune hepatitis and SLE) may require larger sample sizes to detect associations. As a case-control study, it shows associations but cannot establish a causation.

5. CONCLUSION

In conclusion, this study identified a complex interaction between demographic, obstetric, medical, and anatomical factors significantly associated with spontaneous miscarriage among women at Al-Sabeen Hospital in Yemen. Key risk factors included an incompetent cervix, previous miscarriage, psychological disorders, hyperprolactinemia, and living in a rural area.

Most patients were discharged in good condition after uterine evacuation or expectant management. However, a small but important proportion of mothers presented with serious complications that required further procedures, such as blood transfusion or ICU admission.

Key recommendations include enhancing preconception counseling and screening programs to identify and manage risk factors. High-risk pregnancies require intensified antenatal care and frequent checkups. Additionally, increasing community awareness of miscarriage risks and the importance of early care for modifiable factors is critical. Finally, further research is warranted to explore the specific underlying causes of miscarriage in the Yemeni population.

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