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Risk factors affecting abortion among pregnant women– A case-control study

Shima Hashemi [1], Ashraf Direkvand Moghadam [2], Kourosh Sayehmiri [3], Mirhadi Mousavi [4], Hamzeh Ahmadi [5], Monireh Azizi [6], Khairollah Asadollahi [1]✉

[1] Department of Epidemiology, Faculty of Health, Ilam University of Medical Sciences, Ilam, Iran
[2] Department of Midwifery. Faculty of Nursery and Midwifery, Ilam University of Medical Sciences, Ilam, Iran
[3] Department of Biostatistics, Faculty of Health, Ilam University of Medical Sciences, Ilam, Iran
[4] Department of Pediatrics, Faculty of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran
[5] Department of Epidemiology and Biostatistics, Faculty of Public Health, Isfahan University of Medical Sciences, lsfahan, lran
[6] Department of Anatomy, Faculty of Medicine, Ilam University of Medical Sciences, Ilam, Iran

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✉ ***Correspondence to:***
Khairollah Asadollahi
Department of Epidemiology, Faculty of Health, Ilam University of Medical Sciences, Ilam, Iran

Email:
masoud_1241@yahoo.co.uk

A B S T R A C T

Introduction: Abortion, a common pregnancy complication, is influenced by multifaceted reproductive, economic, social, and cultural factors. This study investigates abortion determinants among pregnant women in Khorramabad, Iran, from September 2020 to March 2021.

Material & Methods: This case-control study involved 416 pregnant women (208 cases, 208 controls) selected from Khorramabad health centers through census and random sampling during the COVID-19 pandemic. Data on demographics and pregnancy history were collected using a checklist and analyzed with STATA16.

Results: Among the 416 pregnant women, the mean age was 31.00 ± 5.53 years in the control group and 32.27 ± 6.85 years in the case group. Furthermore, 74 (35.58%) mothers in the case group had a diploma, 192 (92.31%) were housewives, and 106 (50.96%) had A+ blood group. The majority of mothers (46.63% in case, 39.42% in control) had an overweight range of pre-pregnancy BMI (25-29.9) (kg/m2). The mean height was 162.97 ± 5.30 in the control group and 160.86 ± 5.39 in the case group. Multiple regression logistic analysis confirmed significant associations between abortion and mother's age (OR=4.67, 95%CI=1.11-19.62), previous cesarean delivery (OR=4.33, 95%CI=1.94-9.66), not taking folic acid pills during pregnancy (OR=14.92, 95%CI=6.25-35.61), low income (OR=7.00, 95%CI=2.02-24.35), not smoking (OR=0.28, 95%CI=0.08-0.94), and absence of pre-diabetes (OR=0.13, 95%CI=0.03-0.47) ($p < 0.05$). No significant relationships were found between abortion and other studied risk factors.

Conclusion: Older mothers with lower income levels are more likely to experience abortion. Additionally, factors such as pre-existing pre-diabetes, previous cesarean deliveries, smoking, lack of folic acid supplementation, and maternal infections are identified as risk factors for abortion. Providing education, healthcare, and continuous support from healthcare workers can promote safe pregnancies, reduce the risk of abortion, and enhance maternal and child health outcomes.

Keywords: Abortion, Pregnancy, Mothers, Child

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Introduction

Abortion is defined as fetal loss before 20 gestational weeks or ≤500 gram weight (1,2). Abortion is a significant social and health issue worldwide and one of the most complications in the pregnancy which affects women's life (3). In the last decade, the prevalence of spontaneous abortions has increased (4). Spontaneous abortion is defined as fetal loss before twenty gestational weeks which occurs in 10-20% of pregnancies. Many different genetics and physiological factors may cause spontaneous abortion (4,5). According to estimation, around 73 million induced abortions take place worldwide each year. Six out of 10 (61%) of all unintended pregnancies, and 3 out of 10 (29%) of all pregnancies, end in induced abortion (6).

During 2010 to 2014, over than 55.7 million abortions took place each year in the world. About 25.1 million abortions were unsafe and 97% of them occurred in developing countries (7). Annually, 121 million unwanted pregnancies have occurred in the world, which 61% of them resulted in abortion (8). Accurate statistics of abortions in Iran are not available, and according to researches, the number of illegal abortions is about 290,000 annually, and the highest age range for abortions is between 15 and 24 years old (9). Studies showed that there are some factors affecting abortion including: uterine abnormalities, immune system disorders, hormonal disorders, anatomical defects and endometriosis, mother's age, environmental factors, infections, maternal diseases such as genetic disorders and chromosomal abnormalities, endocrine disorders such as hypothyroidism and diabetes, medication use, smoking, alcohol, caffeine, exposure to mobile phone radiation, use of contraceptive drugs, trauma, blood factors and other unknown factors (10-12).

The harmful consequence of abortion on mother's reproductive capability is evident. Abortion leads to a high burden of complications including: bleeding, uterine infection, toxic shock syndrome, sepsis, acute kidney failure, parametrit, peritonitis, and even maternal deaths (13). Abortion is a distressing experience that affects mothers in a variety of ways by influencing on emotional status and may lead to physical disorders, depression, anxiety, sleep disorders and general health complications and reduces the individual's social functioning (14). The consequences of unsafe abortion do not only affect the individual, but also affect the entire health care system because many resources must be spent on treating the complications caused by unsafe abortions (15).

Maternal mortality due to complications of pregnancy and childbirth is one of the most important indicators showing the level of development of countries and consists of a set of different factors, while preventive and appropriate interventions can prevent the occurrence of similar deaths in the future. Abortion is one of the pervasive issues in human societies, which not only requires comprehensive medical and health investigations, but is also the result of countless causes that can be investigated in different jurisprudential, legal and social fields. This study aimed to determine risk factors affecting abortion among pregnant women in a big city located in the west of Iran.

Materials and methods

In this case-control study, 416 pregnant women (208 cases, 208 controls) referred to Khorramabad health centers under the supervision of the Ministry of Health and Medical Education (MOHME) were selected by census sampling as the case group and random sampling as the control group, from September 2020 to March 2021. Written informed consent and verbal agreement was taken from all participants. All experimental protocols were approved by Ilam University of Medical Sciences.

There are 16 health centers in Khorramabad city. Women who had lost their pregnancy under 20 weeks of gestational age were defined as the case group, and women with ongoing pregnancies from 20 to 42 weeks of gestational age were defined as the control group. The sample size was calculated based on the

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number of abortions reported during September 2020 to March 2021 among health centers using the formula below, with an equal number among non-aborted women totaling 416 participants. Women with a history of pregnancy were included in this study. The inclusion criteria for women were being eager to participate and complete the research questions. There was no limitation of age range. The authors excluded those who had no history of marriage and pregnancy, as well as those who had immigrated to other cities and had no printed or electronic health center documents.

$$n = \left[\frac{z_{1-\propto/2}\sqrt{p_1(1-p_1)}+z_{1-\beta}\sqrt{p_1(1-p_1)+p_2(1-p_2)}}{(p_1-p_2)}\right]^2 = 205$$

n (case): 205, n (control): 205, n (total): 410, P1: exposure in cases, P2: exposure in controls, Z1-a/2= 1.96 and Z1-ß= 1.28, CI: 95%, Power: 80%, Population proportion: 2, OR: 2.16

The data were analyzed using STATA 16. P values ≤ 0.05 were considered statistically significant. Continuous variables were presented as mean ± standard deviation, while qualitative variables were expressed as frequency (percent). To investigate the risk factors of abortion, a univariate logistic regression analysis was initially conducted. Variables with p ≤ 0.2 in the univariate analysis were then included in the multiple regression model. Subsequently, variables with p ≤ 0.05 were retained, while others were excluded using a stepwise backward method. The effects on risk were estimated by odds ratios with 95% confidence intervals, and p-values ≤ 0.05 were deemed statistically significant. Variables with a P value < 0.2 were further tested using multivariate analysis, employing backward-elimination multiple logistic regression. This process aimed to identify the most statistically significant variables as risk factors.

Data were collected using a checklist from the Iranian electronic health record information, known as the "SIB" Integrated Health System. The checklist included questions about demographic information, the participant's pregnancy history, the participant's medical history, and socio-economic information. Women with incomplete record information were invited to complete the checklist in person at the health centers where they were enrolled. Written informed consent was obtained from all participants. The checklist was anonymous, and the interviewers were unaware of the name or record number of participants. This study was extracted from an MSc Epidemiology thesis and was approved by Ilam University of Medical Sciences and the Ethics Committee with the approval number IR.MEDILAM.REC.1400.193. All methods were conducted in accordance with relevant guidelines, regulations, or the Declaration of Helsinki.

Results

Based on the results, among the 416 analyzed participants, the mean ± standard deviation age was 31.00 ± 5.53 years in the control group and 32.27 ± 6.85 years in the case group. Additionally, the majority of mothers (74, 35.58%) had a diploma, 192 (92.31%) were housewives, and 106 (50.96%) had A+ blood group in the case group. It was also found that the majority of mothers (97, 46.63%) in the case group and 82 (39.42%) in the control group had an overweight range of pre-pregnancy BMI (25-29.9 kg/m2), respectively. From the total number of women in the control group, 189 (90.87%) had been taking folic acid pills one month before pregnancy. There was a significant association between not using folic acid and abortion (p < 0.0001). Demographic information is presented in Table 1.

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Table 1. Comparison of Demographic Information in Mothers with and without Abortion.

Variables	Category	Case group N (%)	Control group N (%)	P-value
Mother educational level	Elementary to high school	55 (26.44)	51 (24.52)	0.328
	Diploma	74 (35.58)	65 (31.25)	
	Associated degree	22 (10.58)	16 (7.69)	
	BSc	47 (22.60)	65 (31.25)	
	MSc & PhD	10 (4.80)	11 (5.29)	
Mother job status	Housewife	192 (92.31)	185 (88.94)	0.464
	Employee	13 (6.25)	19 (9.14)	
	Self-employee	3 (1.44)	4 (1.92)	
Mother blood group	A+	106 (50.96)	65 (31.25)	<0.0001
	A-	12 (5.77)	1 (0.48)	
	B+	30 (14.42)	23 (11.06)	
	B-	1 (0.48)	4 (1.92)	
	AB+	16 (7.69)	10 (4.81)	
	AB-	0	1 (0.48)	
	O+	40 (19.23)	96 (46.15)	
	O-	3 (1.45)	8 (3.85)	
pre-pregnancy Body Mass Index (BMI) ($\frac{kg}{m^2}$)	≤18.4	1(0.48)	4(1.92)	0.012
	18.5-24.9	51 (24.52)	80 (38.64)	
	25-29.9	97 (46.63)	82 (39.42)	
	30-34.9	48 (23.08)	33 (15.86)	
	≥35	11 (5.29)	9 (4.34)	
Husband educational level	Elementary to high school	54 (25.96)	40 (19.23)	0.131
	Diploma	93 (44.72)	83 (39.90)	
	Associated degree	17 (8.17)	20 (9.62)	
	BSc	31 (14.90)	48 (23.08)	
	MSc & PhD	13 (6.25)	17 (8.17)	
Husband job status	Unemployed	17 (8.17)	10 (4.81)	0.309
	Employee	56 (26.92)	64 (30.77)	
	Self-employee	135 (64.91)	134 (64.42)	
Husband blood group	A+	41 (19.71)	52 (25.0)	0.029
	A-	37 (17.79)	33 (15.87)	
	B+	25 (12.02)	15 (7.21)	
	B-	10 (4.81)	2 (0.96)	
	AB+	26 (12.50)	39 (18.75)	
	AB-	3 (1.44)	0	
	O+	63 (30.29)	62 (29.81)	
	O-	3 (1.44)	5 (2.40)	
Pregnancy type	Wanted	165 (79.33)	169 (81.25)	0.622
	Unwanted	43 (20.67)	39 (18.75)	
Last delivery type	Vaginal	89(59.33)	110(84.62)	<0.0001
	Cesarean	61(40.67)	20(15.38)	
Contraceptive methods	Natural family planning	94 (45.41)	57 (27.40)	0.002
	Condom	70 (33.81)	107 (51.44)	
	Combined pills	25 (12.08)	27 (12.98)	

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	Contraceptive injection	9 (4.35)	7 (3.37)	
	IUD	9 (4.35)	10 (4.81)	
Caffeine consumption	Yes	159 (76.44)	157 (75.48)	0.819
	No	49 (23.56)	51 (24.52)	
Cup of coffee (per day)	0	41 (19.71)	51 (24.52)	0.009
	1	32 (15.38)	56 (26.92)	
	2	46 (22.12)	36 (17.30)	
	3	36 (17.31)	35 (16.83)	
	4	9 (4.33)	9 (4.33)	
	5	15 (7.21)	8 (3.85)	
	6≥	29 (13.94)	13 (6.25)	
Smoking	Yes	47 (22.60)	14 (6.73)	<0.0001
	No	161 (77.40)	194 (93.27)	
Monthly income	≤150 $	42 (20.19)	18 (8.65)	<0.0001
	150-250 $	112 (53.85)	105 (50.49)	
	≥250 $	54 (25.96)	85 (40.86)	
Maternal Disorder	Yes	17(8.17)	4(1.92)	0.004
	No	191(91.83)	204(98.08)	
Maternal Disorder Type	Autoimmune disease	3(15.79)	3(75.0)	0.047
	Metabolic	3(15.79)	0	
	Infections	13(68.42)	1(25.0)	
Acid folic (3 months before pregnancy)	Yes	59(28.37)	114(54.81)	<0.0001
	No	149(71.63)	94(45.19)	
Supplementary (3months before pregnancy)	Yes	22(10.58)	120(57.69)	<0.0001
	No	186(89.42)	88(42.31)	
Acid folic (1 months before pregnancy)	Yes	96(46.15)	189(90.87)	<0.0001
	No	112(53.85)	19(9.13)	
Drug Consumption	Yes	68(32.69)	73(35.10)	0.605
	No	140(67.31)	135(64.90)	
Levothyroxine Use	Yes	24(11.54)	45(21.63)	0.006
	No	184(88.46)	163(78.37)	
Screening	Yes	45(21.63)	115(55.29)	<0.0001
	No	163(78.37)	93(44.71)	
Sonography	Yes	53(25.48)	182(87.50)	<0.0001
	No	155(74.52)	26(12.50)	
Blood Test	Yes	109(52.40)	183(87.98)	<0.0001
	No	99(47.60)	25(12.02)	
First Child (sex)	Male (n=128)	68(45.33)	60(46.15)	0.891
	Female (n= 152)	82(54.67)	70(53.85)	
Second Child (sex)	Male (n= 58)	32(43.84)	26(55.32)	0.219
	Female (n= 62)	41(56.16)	21(44.68)	
Third Child (sex)	Male (n= 7)	3(25.0)	4(33.33)	0.653
	Female (n= 17)	9(75.0)	8(66.67)	

Based on the results, the mean ± standard deviation of pre-pregnancy mother body mass index (BMI) was

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27.83 ± 4.18 kg/m² in the case group and 26.69 ± 4.21 kg/m² in the control group. Other information is summarized in Table 2.

Table 2. Comparison of Demographic Information in Mothers with and without Abortion Based on One Sample t-Test.

Variable	Group	n (%)	Mean ± SD	Std Error	95% CI	P-value
Maternal age (year)	Control	208 (100)	31.00±5.52	0.38	30.25-31.76	0.038
	Case	208 (100)	32.27±6.85	0.47	31.34-33.21	
Husband age (year)	Control	208 (100)	35.25±5.95	0.41	34.44-36.06	0.065
	Case	208 (100)	36.46±7.37	0.51	35.45-37.47	
Weight (kg)	Control	208 (100)	70.79±11.74	0.81	69.18-72.39	0.260
	Case	208 (100)	72.07±11.39	0.78	70.51-73.62	
Height (cm)	Control	208 (100)	162.97±5.30	0.36	162.24-163.69	0.0001
	Case	208 (100)	160.86±5.39	0.37	160.12-161.60	
pre-pregnancy Body Mass Index ($\frac{kg}{m^2}$)	Control	208 (100)	26.69±4.21	0.29	26.11-27.27	0.005
	Case	208 (100)	27.83±4.18	0.29	27.26-28.41	
First Child (age-year)	Control	130 (62.5)	7.86±4.72	0.41	7.04-8.68	0.109
	Case	150 (72.11)	8.88±5.73	0.46	7.96-9.81	
Second Child (age-year)	Control	47 (22.60)	6.85±3.21	0.46	5.90-7.79	0.439
	Case	73 (35.10)	7.45±4.63	0.54	6.37-8.53	
Third Child (age-year)	Control	12 (5.77)	4.83±3.21	0.92	2.79-6.87	0.295
	Case	12 (5.77)	6.91±5.91	1.70	3.15-10.67	

Results of logistic regression analysis showed that with the increase in mother's age, the risk for abortion increased (OR=1.03, 95% CI=1.00-1.06, p-value=0.039). After adjustment for other variables, with the increase in mother's age, the risk for abortion also increased significantly with an odds ratio of 4.67 (95% CI=1.11-19.62). Multiple regression logistic analysis confirmed a significant relationship between abortion and mother's age (OR=4.67, 95% CI=1.11-19.62), previous cesarean delivery (OR=4.33, 95% CI=1.94-9.66), not taking folic acid pills during pregnancy (OR=14.92, 95% CI=6.25-35.61), low income (OR=7.00, 95% CI=2.02-24.35), not smoking (OR=0.28, 95% CI=0.08-0.94), and not suffering from pre-diabetes (OR=0.13, 95% CI=0.03-0.47) ($p < 0.05$). There were no significant associations between abortion and other studied risk factors (Table 3)

Table 3. Univariate and Multivariable Logistic Regression Analysis of Factors Associated with Abortion Among Pregnant Women.

Variables	Category	Case group n (%)	Control group n (%)	Unadjusted OR (95% CI)	P-value	Adjusted OR (95% CI)	P-value
Mother age (year)	<40	181(87.02)	202(97.12)	1		1	
	>40	27(12.98)	6(2.88)	1.03 (1.00-1.06)	0.039	4.67 (1.11-19.62)	0.035
Contraceptive method	Condom	70 (33.81)	107 (51.44)	1		1	
	Natural family planning	94 (45.41)	57 (27.40)	2.52 (1.61-3.93)	0.001	4.46 (1.88-10.53)	0.001
	Combined pills	25 (12.08)	27 (12.98)	1.41 (0.75-2.63)	0.274	2.58 (0.89-7.42)	0.078

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	Contraceptive injection	9 (4.35)	7 (3.37)	1.96 (0.69-5.51)	0.20	7.88 (1.18-52.48)	0.033
	IUD (intrauterine device or coil)	9 (4.35)	10 (4.81)	1.37 (0.53-3.55)	0.51	3.53 (0.71-17.43)	0.120
Last delivery type	Vaginal	89 (59.33)	110 (84.62)	1		1	
	Cesarean	61 (40.67)	20 (15.38)	3.76 (2.11-6.71)	0.000	4.33 (1.94-9.66)	<0.0001
Acid folic pills (one month before pregnancy)	Yes	96 (46.15)	189 (90.87)	1		1	
	No	112 (53.85)	19 (9.13)	11.60 (6.73-20.01)	0.000	14.92 (6.25-35.61)	<0.0001
Maternal disorder	No	191 (91.83)	204 (98.08)	1		1	
	Yes	17 (8.17)	4 (1.92)	0.22 (0.07-0.66)	0.007	3.07 (0.52-17.92)	0.212
Monthly income	≤150 $	42 (20.19)	18 (8.65)	1		1	
	150-250 $	112 (53.85)	105 (50.49)	3.67 (1.91-7.02)	0.000	7 (2.02-24.25)	0.002
	≥250 $	54 (25.96)	85 (40.86)	1.67 (1.08-2.58)	0.019	0.01 (0.46-2.21)	0.965
Smoking	No	161 (77.40)	194 (93.27)	1		1	
	Yes	47 (22.60)	14 (6.73)	0.24 (0.13-0.46)	0.000	3.52 (1.05-11.81)	0.041
Pre-diabetes	No	172 (82.69)	200 (96.15)	1		1	
	Yes	36 (17.31)	8 (3.85)	0.19 (0.08-0.42)	0.000	7.48 (2.10-26.54)	0.002
Mother blood group	O+	40 (19.23)	96 (46.15)	١		1	
	A+	106 (50.96)	65 (31.25)	3.91 (2.41-6.33)	0.000	5.75 (2.43-13.57)	<0.0001
	A-	12 (5.77)	1 (0.48)	28.79 (3.62-228.93)	0.001	10.71 (0.80-142.10)	0.072
	B+	30 (14.42)	23 (11.06)	3.13 (1.62-6.03)	0.001	2.52 (0.69-9.23)	0.16
	B-	1 (0.48)	4 (1.92)	0.6 (0.65-5.53)	0.652	1.01 (0.02-43.50)	0.99
	AB+	16 (7.69)	10 (4.81)	3.84 (1.60-9.18)	0.002	20.74 (4.52-95.12)	<0.0001
	AB-	0	1 (0.48)	1		1	
	O-	3 (1.45)	8 (3.85)	0.41 (0.28-0.60)	0.000	2.40 (0.21-26.43)	0.47

*OR= Odds Ratio, P≤0.05 significant meaning

Mothers under 40 years old who smoked exhibited a higher risk of abortion. The results of the interaction between maternal age and smoking are presented in Table 4. As maternal age increases, the correlation between smoking and abortion risk significantly escalates, surpassing the individual effects of these variables. This phenomenon may be attributed to the cumulative impact of smoking over time.

Table 4. Multivariable Logistic Regression Analysis with the Interaction between Maternal Age and Smoking

Variables	Category	Adjusted Odds Ratio	Std. Error	95% CI	P-value
	<40 years and Not smoking	1			

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Interaction between Mother age and Smoking	<40 years and smoking	7.04	5.63	1.46-33.81	0.015
	>40 years and Not smoking	2.49	2.24	0.42-14.52	0.308
	>40 years and smoking	1.50	0.58	0.69-3.23	0.296
Contraceptive Method	Natural family planning	1			
	Condom	0.19	0.08	0.08-0.45	<0.0001
	Combined pills	0.58	0.30	0.20-1.62	0.302
	Contraceptive injection	1.47	1.42	0.22-9.84	0.688
	IUD	1.08	0.83	0.24-4.91	0.913
Late delivery type	Vaginal	1			
	Cesarean	5.21	2.10	2.36-11.51	<0.0001
Acid folic pills (one month before pregnancy)	Yes	1			
	No	16.93	7.55	7.06-40.61	<0.0001
Pre-diabetes	Yes	1			
	No	0.12	0.07	0.03-0.43	0.001
Monthly income	≤150 $	1			
	150-250 $	0.14	0.09	0.04-0.51	0.002
	≥ 250%	0.15	0.09	0.04-0.53	0.003
Mother blood group	O+	1			
	O-	2.02	2.61	0.15-25.60	0.587
	A+	3.91	2.24	2.31-12.18	<0.0001
	A-	11.64	15.26	0.89-152.11	0.061
	B+	2.68	1.73	0.75-9.53	0.127
	B-	1.15	1.98	0.03-33.71	0.935
	AB+	3.84	13.72	4.11-79.93	<0.0001
	AB-	1			

Discussion

The current study revealed a significant increasing relationship between maternal age and abortion risk, with an adjusted odds ratio of 4.67, after adjusting for multiple covariates, which was statistically significant. Consequently, the risk of abortion in mothers with at least one gravidity was 8% less than nulliparous mothers. Therefore, mothers who had a history of more than two abortions significantly increased the risk of abortion.

The results of this study were consistent with previous studies regarding the association between advanced maternal age and abortion. It is observed that 75% of pregnancies occurred between 15-24 years old (16,17). Based on different studies, advanced maternal age will increase the risk of abortion due to fetal chromosomal disorders. It was reported that the higher risk of abortion came at a maternal age ≥45 years old (18). Erfani (2010) showed a high risk of abortion in maternal age over 35 years old (19). In another study conducted in the United States, maternal age was described as one of the abortion's risk factors (20).

It was reported that the highest abortion ratio was witnessed in women with diploma education, and those who were housewives in both the case and control groups. This may be due to the majority of housewife mothers having a diploma. The risk of abortion was decreased in mothers with academic education (BSc and above), which may be attributed to the lower maternal ages.

The results of this study demonstrated that ABO blood type is associated with abortion. Most women (92.8%) and their husbands (77.6%) had Rh-positive blood groups. Mothers with blood type A negative had 7.35 times the risk of abortion compared to those with blood type A positive. Several epidemiological studies have reported the association between

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abortion and ABO blood types with Rh negativity (21). The higher representation of blood group type A was associated with recurrent abortion rather than ABO blood types (22). Other studies showed a relationship between pregnancy complications and blood group type A (23). Additionally, parental blood group incompatibility may increase the risk of abortion (24). However, the relationship between blood type and infertility and abortion is still controversial.

According to the results of this study, both direct and passive smoking significantly increased the risk of abortion. Additionally, consuming more than 6 cups of tea or coffee per day was found to increase the risk of abortion by 2.77, which aligns with similar findings in the literature (25). Skogsdal (2022) reported that the odds of abortion increased with the number of cigarettes smoked per day, and there was also a significant relationship between abortion and caffeine or alcohol consumption (26). Previous reports suggest that the risk of abortion is 20-80% higher in addicted women (18,27), which may further elevate the risk of spontaneous abortion in nonsmoking women (28). Moreover, consuming 100 mg of caffeine increases the risk of spontaneous abortion by 22% (29).

In fact, caffeine found in coffee can elevate blood pressure and act as a diuretic, leading to dehydration, which can have negative effects on the body. If caffeine reaches the fetus during pregnancy, it can reduce blood flow to the placenta, potentially harming the fetus. Smoking during pregnancy is also known to increase the risk of health problems for both the mother and the fetus. Therefore, it is crucial to raise awareness among mothers about the negative impacts of smoking and excessive caffeine consumption during pregnancy, particularly in health centers.

According to the results of the present study, there was a significant relationship between maternal diseases (infections), a history of abnormal fetal birth, and abnormalities confirmed in amniocentesis with abortion. Additionally, a mother's history of pre-diabetes increased the likelihood of abortion. These findings are consistent with results from various other studies.

Bacterial infections rank among the most common infectious diseases worldwide, exerting adverse effects on sexual and reproductive health (30). Such infections can elevate the risk of ectopic pregnancy in women, leading to sudden and severe bleeding. Moreover, pregnant women afflicted with these infections may encounter complications such as miscarriage, preterm delivery, stillbirth, ectopic pregnancy, and fetal abnormalities (31). Studies have indicated that maternal infection by mycoplasma is associated with abortion. Additionally, women with uncontrolled diabetes tend to experience a higher rate of miscarriage, although the precise mechanism underlying this phenomenon remains unknown (18).

In this study, a majority of 45.41% of mothers in the case group utilized natural family planning, while 51.44% opted for condom use in the control group as contraceptive methods, revealing a significant relationship. A study indicated that induced abortion was associated with mothers' use of natural family planning (32). Conversely, contraceptive pills served as a preventive factor, reducing the risk of abortion by 43%, a finding consistent with other studies (33,34). This might be attributed to the therapeutic effects of contraceptive pills, which, in addition to contraception, are sometimes employed to prevent ovarian cysts or strengthen follicles (35).

The results of this study demonstrated that the risk of abortion increased with the number of pregnancies, children, and cesarean deliveries, while children's sex did not emerge as a significant risk factor for abortion. These findings are in line with similar studies (36,37). One significant factor contributing to increased abortion risk is advanced maternal age, which heightens the likelihood of fetal chromosomal disorders (18). Additionally, the increased number of children, coupled with insufficient time for mothers to engage in physical activity and the influence of an

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unhealthy lifestyle, may elevate the likelihood of underlying diseases and abortion.

Furthermore, the risk of abortion was found to increase with decreasing monthly income. Prior research has demonstrated the impact of income on fertility behaviors (38). Mahmoudiani (2018) highlighted a higher incidence of abortion in lower-income families (37), and numerous studies have confirmed the correlation between lower income and abortion (39,40).

According to the results, mothers taking folic acid pills (one or three months before pregnancy) experienced a decreased risk of abortion, suggesting a preventive effect. A study conducted in England, examining the levels of riboflavin and folic acid in the serum of women experiencing spontaneous abortions in the first and second trimesters of pregnancy, revealed a high prevalence of deficiency, reaching 84% (41). This underscores the importance of screening pregnant women for nutritional deficiencies and recommending supplementation, such as folic acid, to prevent abortion and other pregnancy complications.

Future research

Future qualitative research studies could be done to define genetics factors resulting in abortion besides environmental factors among pregnant women.

Conclusion

Advanced maternal age and lower income were significantly associated with an increased risk of abortion. Additionally, suffering from pre-diabetes, a history of previous cesarean pregnancy, smoking, not taking folic acid pills, and maternal disorders (infection) were identified as potential risk factors for abortion. None of the covariates studied modified the association between maternal risk factors and abortion. Providing education, healthcare, and fostering continuous interaction between healthcare workers and mothers are essential measures to promote safe pregnancies and deliveries and decrease the risk of abortion.

Limitation and strengths of the study

In this study, the most significant limitation was the absence of information regarding potential early abortions that were either unreported by mothers or not recorded in the system. Additionally, the incompleteness of certain data in the electronic records of pregnant mothers or the outcomes of newborns posed another limitation to this project. However, these limitations were mitigated to some extent through telephone or face-to-face follow-up efforts.

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Conflict of interest

There are no conflicts of interest to declare.

Authors' contributions

HS and AK conceived the initial idea, collected data, and drafted the primary manuscript. SK assisted in the analysis of the data. DA, MM, and AH reviewed and provided critical feedback on the manuscript. All authors approved the final manuscript as submitted and agreed to be accountable for all aspects of the work.

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