

## Investigation of the Maternal and Neonatal Factors Affecting the Apgar score of Newborns: A Case-Control Study

Khairollah Asadollahi<sup>1</sup>, Arezoo Karimi<sup>2</sup>, Zahra Bagheri-Hosseini<sup>3</sup>, Nazanin Rezaei<sup>4</sup>,  
MirHadi Mussavi<sup>5</sup>, \*Salman Daliri<sup>6,7</sup>

<sup>1</sup>Department of Social Medicine, Faculty of Medicine, Ilam University of Medical Sciences, Ilam, Iran. <sup>2</sup>Department of Epidemiology, School of Public Health, Shahroud University of Medical Sciences, Shahroud, Iran. <sup>3</sup>Department of Clinical Biochemistry, Faculty of Medicine, Rafsanjan University of Medical Sciences, Rafsanjan, Iran. <sup>4</sup>Department of Midwifery, Faculty of Nursing and Midwifery, Ilam University of Medical Sciences, Ilam, Iran. <sup>5</sup>Department of Pediatrics, Faculty of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran. <sup>6</sup>Clinical Research Development Unit, Imam Hossein Hospital, Shahroud University of Medical Sciences, Shahroud, Iran. <sup>7</sup>Student Research Committee, School of Health, Ilam University of Medical Sciences, Ilam, Iran.

### Abstract

**Background:** Apgar score is a method for clinical evaluation of neonate at birth, and predicts their clinical conditions and physical or mental development. This study aimed to investigate the relationship between some neonatal and maternal factors during pregnancy on the Apgar score.

**Materials and Methods:** This case-control study was conducted on 234 neonates born in Ilam hospitals during 2015-2016. The case group included 81 neonates with Apgar score <7 and control group containing 153 neonates with Apgar score ≥7 in minute 1 as well as 48 cases and 96 controls in minute 5.

**Results:** The mean maternal weights in the case and control groups were  $66.8 \pm 13.5$  and  $67.1 \pm 11.1$  Kg, respectively. The mean  $\pm$  SD for maternal age  $29 \pm 5$  vs.  $29 \pm 5.7$  years, marriage age  $22 \pm 3$  vs.  $22.2 \pm 4.9$  years, BMI  $24.5 \pm 3.2$  vs.  $26.1 \pm 4.1$  and weight gain during pregnancy  $13.8 \pm 6.2$  vs.  $12.7 \pm 6.8$  kg among cases and controls, respectively. The odds ratio for the following factors was significantly higher among cases than the control group: preterm delivery (OR: 3.3, 95% CI: 1.2-17), twin birth (OR: 8.9, 95% CI: 2.6-27.2), abnormal presentation of the fetus (OR: 6, 95% CI: 2.3-15.6), birth weight (OR: 6.9, 95% CI: 1.4-28.6), and placental abruption (OR: 9.4, 95% CI: 2.2-22.5) for Apgar score at five minute.

**Conclusion:** Based on the findings of the present study, preterm labor, multiple birth, and abnormal fetal presentation, and low birth weight, premature rupture of membrane, placental abruption and anemia, led to an increase in Apgar score less than 7.

**Key Words:** Apgar score, Neonatal, Maternal factor, Pregnancy, Odds ratio.

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### \*Corresponding Author:

Salman Daliri, School of Public Health, Shahroud University of Medical Sciences, Shahroud, Iran.

Email: [salmandaliri@yahoo.com](mailto:salmandaliri@yahoo.com)

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## 1- INTRODUCTION

Apgar score is a quick and accurate worldwide method for determination of clinical status of neonates during the first few minutes of their birth. The Apgar score is based on five clinical indicators of neonate including body appearance and color, number of heart beats, respiratory rate, physical activity and crying of the neonate (1, 2). A low Apgar score at the first minutes of life indicates the needs for recovery and special care operations. Following the submission of special services, follow up and reviewing the Apgar score in minutes 5, 10, and 20 is a matter of necessity. So, if the Apgar score continues to be low, it alarms the possibility of injury from infantile instability or severe consequences such as death and severe physical or neurological injuries. In this case, the need for application of medical services and interventions is inevitable, and there is the need for urgent medical services and interventions (3, 4).

Apgar score is affected by various factors such as, congenital anomalies, preterm delivery, cesarean delivery, fetal appearance, multiple birth, placental abruption, breech presentation and several maternal or infantile factors, which can reduce or improve this score (3-5). Alianmoghaddam and colleagues reported a reverse correlation between maternal blood lead levels and neonatal Apgar score, so that, increasing the rate of lead in the maternal bloodstream caused a reduction of the neonatal Apgar score. They also reported that female gender, low birth weight, smoking, and chronic underlying conditions were related to the lower rate of Apgar score (6, 7). Rahi and others showed that maternal addiction during pregnancy reduced the Apgar score of 1, 5 and 10 minutes (8). Anemia and diabetes during pregnancy are other factors associated with neonatal Apgar score (9, 10). In a study in Brazil, there was a

significant correlation between maternal age and Apgar score, but in the study conducted in Spain there was no correlation between BMI and neonatal Apgar score (11, 12). In a study from Canada, preeclampsia caused a 2.82-fold increase in the chance of occurring Apgar score < 7 (13). In a study by Manriquez et al. from Chile, Apgar score less than 7 resulted in a 4-fold increase in neonatal death(14). Also, in a study by Kropiwiec et al. from Brazil, the Apgar score < 7 resulted in a 4.8-fold increase in neonatal death (15). In general, it can be stated that, various factors during pregnancy including preterm delivery, low birth weight, preeclampsia, intrauterine growth retardation, congenital anomalies, etc. are associated with Apgar scores and these factors are related to some of the neonatal and maternal characteristics during pregnancy, which can lead to adverse outcomes in newborns (16-18).

A low Apgar score at birth indicates the possibility of adverse outcomes of neonate and the need for intensive medical interventions at birth. Preventing the occurrence of low Apgar score among neonates via controlling of its associated factors during pregnancy can restrain the occurrence of undesirable clinical consequences at birth among neonates. Therefore, the aim of this study was to investigate the relationship between neonatal and maternal factors during pregnancy and Apgar score of neonates in 1 and 5 minutes in Ilam, Iran, during 2015-2016.

## 2- MATERIALS AND METHODS

### 2-1. Study design and population

By a case-control study all neonates born in Mostafa and Kowsar hospitals in Ilam city, Iran, during 2015-2016 were evaluated. Sample size considering the prevalence of 25% clinical adverse outcome in the control group and 43% in the case group, 95% confidence interval

and 80% power and ratio 1/2 case to control, was estimated to be 234 neonates. An informed consent was obtained from all parents' patients and participants were divided into two groups. All neonates with Apgar score less than 7 in 1 minute were selected as cases and at the same time, two neonates with Apgar score equal or more than 7 in 1 minute were considered as controls and their required information were collected. For better adjustment of neonatal characteristics, the selection of cases and controls was performed simultaneously, so that for every neonate with a low Apgar score, two neonates born at the same time and hospital, having inclusion criteria, were considered as the control group. In total, 234 neonates were enrolled in the study, of which 81 were registered as case group and 153 neonates as control group.

## 2-2. Inclusion and exclusion criteria

Inclusion criteria included: livebirth in the hospital, recorded Apgar score in 1 and 5 minutes, living in Ilam and availability of maternal information during pregnancy and the neonate at birth. Exclusion criteria included: stillbirth, lack of Apgar score in minutes one and five, living out of the county or province, lack of consent form, and lack of access to maternal or neonatal information.

## 2-3. Method

At the first step, required information of neonates and their mothers was extracted from their hospital documents. Then, the health conditions of mothers and the events occurred during their pregnancies were collected from their family dossiers inside the health centers. Participants were contacted by phone in case of missing information inside their relevant files. A researcher-made questionnaire was used to extract information. For validity and reliability of the questionnaire, after getting comments from several epidemiologists and neonatal specialists,

24 (10%) questionnaires were primarily completed as pilots and using statistical methods, it was verified and confirmed by Cronbach's alpha of 0.76. The questionnaire included all the required and relevant information, including Apgar score, Preeclampsia, Mother's blood group, Mother's blood Rh, Multiple birth, PROM, Birth weight, Fetal presentation, Type of delivery, Previous delivery type, Placenta previa, Placental abruption, Asphyxia, Meconium excretion, Prematurity, Gender, Consanguinity marriage, Age in marriage, Bleeding during pregnancy and chronic underlying diseases. Based on this, N.Z by referring to the mentioned hospitals, the health centers and interviewing the by infants' families obtained the required information and entered the questionnaire.

## 2-4. Ethical consideration

To carry out this study from the Ilam University of Medical Sciences Ethics Committee approval was obtained (Ethics code: ir.medilam.rec.1396.11).

## 2-5. Statistical analysis

Data were analyzed via SPSS software version 22.0 (Inc. in Chicago. USA) and descriptive statistical methods were used for estimation of mean  $\pm$  SD or frequencies of data. The odds ratio was estimated for possible relationship between different factors and their outcomes among cases and controls. Chi-square and Fisher's exact test were applied for these comparisons accordingly and a level of  $\leq 0.05$  was considered as significant.

## 3- RESULTS

A total of 234 neonates including 81 cases with Apgar score  $<7$  at one minute and 153 controls with Apgar score  $\geq 7$  at one minute and 48 cases with Apgar score  $<7$  at five minute and 96 controls with Apgar score  $\geq 7$  at five minute were analyzed. The mean  $\pm$  SD of maternal weight in the case and control groups was  $66.8 \pm 13.5$  and  $67.1 \pm 11.1$  kg,

respectively. The mean  $\pm$  SD of maternal age  $29 \pm 5$  vs.  $29 \pm 5.7$  years, age of marriage  $22 \pm 3$  vs.  $22.2 \pm 4.9$  years, BMI  $24 \pm 3.2$  vs.  $26.1 \pm 4.1$  and maternal weight gain  $13.8 \pm 6.2$  vs.  $12.7 \pm 6.8$  kg during pregnancy was among cases and controls respectively. The odds ratios for child birth with Apgar score  $<7$  at one minute for factors such as birth in  $\leq 28$  weeks were: OR: 10.7 (95% CI: 2.7-17.1), low birth weight OR: 6.8 (95% CI: 1.3-13.7), breech presentation OR: 8.3 (95% CI: 2.1-14.2), birth in 29 -36 weeks OR: 6.9 (95% CI: 2.9-17.7), placental abruption OR: 4.2 (95% CI: 1.2- 8.6), multiple birth OR: 3.8 (95% CI: 1.3-11.2), and previous cesarean delivery OR: 2.4 (95% CI: 1.2-4.7), respectively (Table.1). The findings of this study revealed a significant relationship between neonatal and maternal

characteristics during pregnancy with Apgar score at five minute. The odds ratios for neonatal birth with Apgar score  $<7$  at five minute for factors such as born in  $\leq 28$  weeks OR: 8.7 (95% CI: 1.9-26.2), low birth weight OR: 6.9 (95% CI: 1.4-28.6), placental abruption OR: 9.4 (95% CI: 2.2-22.5), twin birth OR: 8.9 (95% CI: 2.6-27.2), multiple birth OR: 6.7 (95% CI: 2.1-27.8), breech presentation OR: 6.0 (95% CI: 2.3-15.6), born in 29 -36 weeks OR: 3.7 (95% CI: 1.2-17), bleeding during pregnancy OR: 3.3 (95% CI: 1-13.9), heart diseases OR: 4.1 (95% CI: 1.2-9.5), injury during pregnancy OR: 4.1 (95% CI: 1.2-9.5), and premature rupture of membrane 1.6 (95% CI: 1.03-6.7) were respectively (Table.2).

**Table-1:** Relationship between some neonatal and maternal characteristics during pregnancy with Apgar score in the 1st minute of birth.

Variables		Apgar minute 1				Apgar minute 1					
		Case Number (%)	Control, Number (%)	OR (95% CI)	P-value	Variables	Case Number (%)	Control, Number (%)	OR (95% CI)	P-value	
Preeclampsia	Yes	12 (22.2)	20 (13.4)	1.8 (0.5-6.3)	0.3	Diabetic	Yes	7 (8.8)	7 (4.8)	1.9 (0.5-6.9)	0.32
	No	41 (77.8)	133 (86.6)	1.0			No	74 (91.2)	146 (95.5)	1.0	
Mother's blood group	A	17(21)	54 (36)	0.4 (0.21 -2.5)	0.06	Gestational diabetic	Yes	6 (7.1)	9 (5.7)	1.3 (0.3-4.6)	0.7
	B	21(24)	31 (20)	1.0 (0.4-2.4)	0.9		No	75 (92.9)	144 (94.3)	1.0	
	AB	9(10)	20 (13)	0.6 (0.2-4.6)	0.6	Injury during pregnancy	Yes	1 (1.8)	1 (1)	1.0 (0.9-1.0)	0.17
	O	34(41)	48 (31)	1.0			No	80 (98.2)	152 (99)	1	
Mother's Rh	Positive	70(87)	127 (83.3)	1.3 (0.5-3.4)	0.6	Infectious disease	Yes	14 (18.2)	50 (32.4)	0.5 (0.2-1.0)	0.06
	Negative	11(13)	26 (16.7)	1.0			No	67 (81.8)	103 (67.6)	1.	
Multiple birth	Single birth	60 (73.2)	140 (91.3)	1.0	0.01	Respiratory disease	Yes	1 (1.8)	3 (1.9)	0.9 (0.08-10.3)	1.0
	Twin	14 (17.9)	9 (5.8)	3.8 (1.3-11.2)			No	80 (98.2)	150 (98.1)	1.0	
	Polytocous	7 (8.9)	4 (2.9)	3.8 (1.1-16.7)		0.04	Heart disease	Yes	1 (1.8)	1 (1)	1.0 (0.9-1.0)
PROM	Yes	19 (23.6)	31 (20.2)	1.2 (0.6-2.7)	0.7	No		80 (98.2)	152 (99)	1.0	
	No	62 (76.4)	121 (79.8)	1.0		Hypertension	Yes	13 (15.8)	7 (6.7)	2.6 (0.9-7.5)	0.09
Birth weight	<2500	47 (58.9)	21 (14)	6.8 (1.3-13.7)	0.001		Thyroid disease	Yes	7 (8.8)	7 (4.8)	
	2500- 3500	21 (25)	64 (60)	1.0		No		74 (89.7)	146 (95.2)	1.0	
	>3500	13 (16.1)	38 (26)	1.5 (0.6-3.8)		0.45	History of infertility	Yes	3 (3.5)	15 (9.5)	0.3 (0.07-1.6)
Fetal presentation	Breech	47 (53.4)	12 (7.1)	8.3 (2.1-14.2)	0.001	No		78 (96.5)	138 (90.5)	1.0	
	Normal	34 (37.9)	141 (92.9)	1.0		Unwanted pregnancy	Yes	9 (11.1)	34 (32.4)	0.3 (0.1-1.7)	0.4
Type of delivery	Cesarean section	43 (53.8)	77 (50.7)	1.2 (0.4-2.1)	0.8						

	Vaginal	38 (46.2)	76 (49.3)	1.0			No	72 (88.9)	119 (67.6)	1.0			
Previous delivery type	Cesarean section	23 (28.1)	81 (53.9)	2.4 (1.2-4.7)	0.01	Mother's job	Housewife	75 (93.8)	143 (93.3)	1.0	1.0		
	Vaginal	58 (71.9)	72 (45.6)	1.0			Employed	6 (4.2)	10 (6.7)	1.08 (0.3-4.4)			
Placenta previa	Yes	1 (1.8)	2 (1.9)	1.0 (0.08-10.5)	1.0	Mother's education	Under diploma	40 (32.1)	41 (25)	1.9 (0.8-4.3)	0.14		
	No	80 (98.2)	151 (98.1)	1.0			diploma	35 (26.8)	49 (35.9)	1.0			
Placental abruption	Yes	7 (8.9)	1 (1)	4.2 (1.2- 8.6)	0.02		Upper diploma	2 (1.8)	63 (38.9)	1.2 (0.5-2.5)	0.8		
	No	74 (91.1)	152 (99)	1.0			<18	1 (1.8)	4 (2.9)	0.5 (0.05-5.4)			
Asphyxia	Yes	1 (1.8)	1 (1)	1.9 (0.1- 30.8)	1.0	Mother's age at pregnancy	18 - 30	41 (57.1)	77 (50)	1.0	0.16		
	No	80 (98.2)	152 (99)	1.0			31 - 35	14 (17.9)	44 (28.8)	0.5 (0.2-1.3)			
Meconium excretion	Yes	7 (8.9)	4 (2.9)	3.3 (0.7-14.5)	0.12		>35	19 (23.2)	28 (18.3)	1.11 (0.5-2.6)	0.8		
	No	74 (91.1)	149 (97.1)	1.0			<50	10 (10)	5 (2.9)	3.7 (0.8-17.2)			
Prematurity	<28 weeks	20 (24.7)	8 (5.2)	10.7 (2.7-17.1)	0.001	Mother's weight at pregnancy	≥50	71 (90)	148 (97.1)	1.0	0.09		
	29 - 36 weeks	32(39.5)	20 (13.0)	6.9 (2.9-17.7)	0.001		Number of deliveries	≤2	63 (77.2)	101 (65.7)		1.8 (0.9-2.7)	0.5
	≥37 weeks	29 (35.8)	125 (81.8)	1.0	>2			18 (22.8)	52 (34.3)	1.0			
Gender	Boy	44 (52.6)	76 (48.6)	1.2 (0.6-2.2)	0.37	Parity	≤2	65 (80.7)	114 (74.3)	1.8 (0.9-3.3)	0.07		
	Girl	27 (47.4)	77 (50.5)	1.0			>2	16 (19.3)	39 (25.7)	1.0			
Birth order	≤2	64 (79.3)	112 (73.3)	1.0	0.3	History of abortion	Yes	18 (22.8)	25 (16.2)	1.5 (0.7-3.4)	0.3		
	>2	17 (21.1)	41 (26.7)	1.4 (0.7-2.6)			No	63 (77.2)	128 (82.9)	1.0			
Time of birth	AM	29 (37)	76 (50)	0.6 (0.3-0.2)	0.16	History of stillbirth	Yes	4 (5.3)	1 (1)	5.8 (0.6-26.8)	0.12		
	PM	52 (63)	77 (50)	1.0			No	77 (94.7)	152 (99)	1.0			
Birth season	Spring	28 (35.3)	50 (32.7)	1.05 (0.5-1.5)	1.0	Contraceptive method	OCP	19 (20.6)	50 (32.3)	0.5 (0.2-1.4)	0.25		
	Summer	20 (24.7)	40 (26.1)	0.92 (08-1.04)	1.0		ampoules	3 (5.9)	1 (1)	7.3 (0.9- 18.2)		0.2	
	Autumn	21 (25.9)	42 (27.5)	0.91 (0.76-1.06)	1.0		IUD	2 (2.9)	4 (3.1)	0.8 (0.07-8.0)			1.0
	Winter	12 (14.1)	21 (13.7)	1.0			Other	6 (5.2)	19 (11.5)	0.7 (0.2-2.6)		0.74	
Consanguinity marriage	Yes	16 (19.6)	48 (31.7)	0.5 (0.2-1.1)	0.1		No method	51 (61.8)	79(52.1)	1.0	1.0		
	No	65 (80.4)	105 (68.3)	1.0			Birth interval	≤ 3	27 (32.2)	40 (20.8)		1.0 (0.4-2.4)	
Age in marriage	<18	3 (5.4)	15 (10.1)	0.5 (0.1-2.3)	0.5		>3	54 (67.8)	113 (69.2)	1.0	0.01		
	18 -30	56 (91.9)	122 (82.8)	1.0			Anemia before pregnancy	Yes	22 (28.8)	15 (10.3)		3.5 (1.5-8.6)	
	> 30	2 (2.7)	10 (7.1)	0.3 (0.04-2.9)	0.4	No	54 (71.2)	130 (89.7)	1.0				
Bleeding during pregnancy	Yes	6 (7)	10 (6.7)	1.0 (0.3-3.8)	1.0	Anemia during pregnancy	Yes	26 (34.6)	31 (21.6)	1.9 (0.9-4.0)	0.11		
	No	75 (93)	143 (93.3)	1.0			No	22 (65.4)	114 (78.4)	1.0			

**Table-2:** Relationship between some neonatal and maternal characteristics during pregnancy with Apgar score in the 5th minute of birth.

Variables		Apgar minute 5				Apgar minute 5					
		Case Number (%)	Control, Number (%)	OR (95% CI)	P-value	Variable	Case Number (%)	Control, Number (%)	OR (95% CI)	P-value	
Preeclampsia	Yes	10 (22.2)	14 (14.4)	1.6 (0.6-5.9)	0.3	Gestational diabetes	Yes	1(2)	7 (7.3)	0.3 (0.03-1.1)	0.36
	No	38 (77.8)	82 (85.6)	1.0			No	47 (98)	89 (92.7)	1.0	
Mother's blood group	A	8 (16.7)	30 (32.3)	0.4 (0.1-1.4)	0.16	Injury during pregnancy	Yes	2 (4.3)	1 (0.7)	4.1 (1.2-9.5)	0.03
	B	12 (25)	22 (22.7)	0.9 (0.3-2.8)	1.0		No	46 (95.7)	95 (99.3)	1.0	
	AB	8 (16.7)	13 (13.1)	1.02 (0.3-4.2)	1.0	Infectious disease	Yes	17 (34.8)	25 (26.3)	1.5 (0.6-3.8)	0.45
	O	18 (41.7)	31 (32.8)	1.0			No	31 (65.2)	71 (73.3)	1.0	
Mother's Rh	Positive	44 (91.7)	80 (83.2)	2.2 (0.5-10.1)	0.3	Respiratory disease	Yes	2 (4)	2 (2.2)	2.0 (0.9-5.0)	1.0
	Negative	4 (8.3)	16 (16.8)	1.0			No	46 (96)	94 (97.8)	1.0	
Multiple birth	Single birth	26 (54.2)	87 (90.4)	1.0	0.0001	Heart disease	Yes	2 (4)	1 (0.7)	4.1 (1.2-9.5)	0.03
	Twin	16 (33.8)	6 (5.9)	8.9 (2.6-27.2)			No	46 (96)	95 (99.3)	1.0	
	Polytocus	6 (12.5)	3 (3.7)	6.7 (2.1-27.8)	0.04	Hypertension	Yes	6 (12.5)	9 (9.4)	1.4 (0.4-5.2)	0.7
PROM	Yes	13 (37.5)	18 (18.5)	1.6 (1.03-6.7)	0.05		No	42 (87)	87 (90.6)	1.0	
	No	35 (62.5)	78 (81.5)	1.0		Thyroid disease	Yes	8 (16.7)	8 (4.3)	2.2 (0.6-8.9)	0.4
Birth weight	< 2500	38 (79.1)	29 (30.2)	6.9 (1.4-28.6)	0.0001		No	40 (83.3)	88 (95.7)	1.0	
	2500 - 3500	8(16.7)	42 (43.8)	1.0		History infertility	Yes	2 (4.2)	8 (8)	0.5 (0.06-4.0)	1.0
	> 3500	2 (4.2)	25 (26.0)	0.4 (0.09-8)	1.0		No	46 (95.8)	88 (92)	1.0	
Fetal presentation	Breech	27 (59.1)	19 (19.4)	6 (2.3-15.6)	0.0001	Unwanted pregnancy	Yes	6 (13.6)	26 (27)	0.4 (0.1-1.5)	0.28
	Normal	19 (40.9)	77 (80.6)	1.0			No	42 (86.4)	70 (73)	1.0	
Type of delivery	Cesarean section	32 (66.7)	49(51.3)	1.8 (0.8-5.5)	0.26	Mother's job	Employed	2 (4.3)	7 (6.2)	0.6 (0.02-1.4)	1.0
	Vaginal	16 (33.3)	47 (48.7)	1.0				46 (95.7)	89 (93)	1.0	
Previous delivery type	Cesarean section	14 (29.2)	41 (43.0)	0.55 (0.07-4.7)	0.26	Mother's education	Under diploma	16 (33.3)	26 (26.6)	2 (07-4.9)	0.56
	Vaginal	34 (70.8)	55 (57.0)	1.0			Diploma	10 (20.8)	33 (34.8)	1.0	
Placenta previa	Yes	2 (4.2)	1 (1.5)	4.6 (0.7-36.8)	0.38		Upper diploma	22 (45.8)	37 (38.6)	1.7 (0.6-4.8)	0.4
	No	46 (95.8)	95 (98.5)	1.0			<18	2 (4.2)	2 (2.2)	1.8 (0.2-18.8)	0.5
Placental abruption	Yes	8 (16.7)	2 (2.0)	9.4 (2.2-22.5)	0.005	Mother's age at pregnancy	18 -30	26 (54.2)	50 (52.2)	1.0	0.57
	No	40 (83.3)	94 (98.0)	1.0			31- 35	8 (16.7)	25 (26.5)	0.6 (0.2-2)	
Asphyxia	Yes	1 (2)	1 (1.5)	2.0 (0.4-8.6)	0.9		>35	12 (25)	19 (19.1)	1.3 (0.4-3.7)	0.8
	No	47 (98.0)	95 (98.5)	1.0			Mother's weight at pregnancy	<50	3 (5.6)	4 (4.8)	1.5 (0.1-10.2)
Meconium excretion	Yes	4 (8.3)	4 (4.4)	2.0 (0.4-8.6)	0.9	≥50		45 (94.4)	92 (95.2)	1.0	
	No	44 (91.7)	92 (95.6)	1.0		Number of deliveries	≤2	36 (75)	66 (68.9)	0.7 (0.3-1.8)	0.5
Prematurity	< 28 weeks	28 (58.4)	19 (19.8)	8.7 (1.9-26.2)	0.0001		>2	12 (25)	30 (31.1)	1.0	

	29 - 36 weeks	10 (20.8)	18 (18.8)	3.3 (1.2-17)	0.01	Parity	≤2	38 (79.1)	73 (76.1)	1.2 (0.4-2.5)	1.0
	≥37 weeks	10 (20.8)	59 (61.4)	1.0			>2	10 (20.8)	23 (23.9)	1.0	
Gender	Boy	24 (50)	48 (50)	1.0 (0.4-2.4)	1.0	History of abortion	Yes	10 (20.8)	17 (18.1)	1.2 (0.4-3.5)	0.7
	Girl	24 (50)	48 (50)	1.0			No	38 (79.2)	79 (81.2)	1.0	
Order birth	≤2	38 (79.1)	71 (74.7)	1.0	0.38	History of stillbirth	Yes	4 (8.3)	1 (1.4)	6.2 (0.8-36.1)	0.1
	>2	10 (20.8)	25 (24.6)	0.7 (0.3-1.6)			No	44 (91.7)	95 (98.6)	1.0	
Time of birth	AM	18 (40)	45 (46.5)	0.7 (0.3-2)	0.6	Contraceptive method	OCP	11 (21.4)	29 (30.2)	0.8 (0.2-3.2)	1.0
	PM	30 (60)	51 (53.5)	1.0			Ampoules	3 (7.1)	2 (1.7)	3 (0.8-5.8)	0.1
Birth season	Spring	16 (33.3)	33 (34)	0.07 (0.03-1.84)	1.0		IUD	3 (7.1)	3 (2.6)	3.0 (0.3-33.3)	0.36
	Summer	18 (41.7)	22 (22.7)	2.3 (0.8-5.2)			1.0	Other	7 (14.3)	10 (10.3)	1.5 (0.3-8.2)
	Autumn	6 (8.3)	29 (30.3)	0.32 (0.4-0.28)	1.0		No method	24 (50)	52 (55.2)	1.0	
	Winter	8 (16.7)	12 (13)	1.0			Birth interval	≤3	10 (21.4)	32 (32.9)	0.5 (0.07-1.6)
Consanguinity marriage	Yes	8 (16.7)	28 (29.4)	0.5 (0.2-1.5)	0.22	>3	38 (78.6)	64 (67.1)	1.0		
	No	40 (83.3)	68 (70.6)	1.0		Anemia before pregnancy	Yes	13 (26.1)	14 (15.1)	2 (0.7-5.7)	0.22
Age in marriage	<18	2 (4.2)	2 (2.2)	1.8 (0.96-5.2)	0.2	No	35 (73.9)	82 (84.6)	1.0		
	18 -30	45 (93.4)	85 (88.6)	1.0		Anemia during pregnancy	Yes	13 (26.1)	25 (26.2)	1 (0.4-2.7)	1.0
	>30	1 (2.1)	9 (9.2)	0.2 (0.02-1.2)	0.3	No	35 (73.9)	71 (73.8)	1.0		
Bleeding during pregnancy	Yes	8 (16.7)	5 (5.1)	3.7 (1-13.9)	0.05	Diabetic	Yes	2 (4.2)	6 (6.5)	0.6 (0.07-5.2)	1.0
	No	40 (83.3)	91 (94.9)	1.0			No	46 (95.8)	90 (93.5)	1.0	

#### 4- DISCUSSION

The present study was conducted as a case-control study on the relationship between maternal and neonatal factors with Apgar score at birth in a two-year period in Ilam city, Iran. These relationships were analyzed in both Apgar score 1 and 5 minute after delivery. Based on the findings of this study, twin, multiple birth, breech presentation, and placental abruption, low birth weight, birth at under 28 weeks, birth between 29 and 36 weeks increased the chance of neonatal birth with Apgar scores < 7. In a study by Jeganathan et al. (2017) from Malaysia, the breech presentation did not show a significant association with the Apgar score less than 7 (19). In that study, some variables such as placenta Previa, placental abruption and type of delivery, that are related to breech presentation, were matched for cases and

controls and this issue may justify their results that why breech presentation did not show a significant association with the Apgar score less than 7 in their study. Zakaria et al., reported a significant association between breech presentation as well as premature rupture of membrane with a low Apgar score of neonates (3), which was in accordance with our findings. Shen et al. (2017) from Canada showed that preeclampsia leads to an increase in neonatal birth with Apgar score less than 7 (20). Various factors such as premature rupture of membrane, breech presentation and twin birth have been identified as risk factors during pregnancy and can lead to adverse outcomes such as low birth weight, preterm delivery, abortion and stillbirth (21). Consequently, based on the findings of the current and similar studies, an interaction or synergic

effects of the above-mentioned factors may worsen the rate of Apgar score at birth and therefore, they can be considered as risk factors for reducing the Apgar scores of neonates. In our study, preterm labor had a very strong correlation with the Apgar score of neonate. As the gestational age increased, the incidence of Apgar score less than 7 was decreased. In a study conducted by Silva et al. (2014) in Brazil, there was a significant relationship between preterm delivery and Apgar score less than 7 (21). Zakaria et al. (2010) from Iran also reported a significant relationship between preterm delivery and low Apgar score(3), which were in accordance with the findings of the current study. Other studies also reported significant relations between low Apgar score and preterm delivery, abortion and twin births (3, 17, 21). However, a study by Jeganathan et al. (2017) reported inversely and a significant correlation between low birth weight and Apgar score less than 7 was not confirmed in their study (19).

It seems that low birth weight as well as preterm delivery are directly associated with Apgar score since some of the indices applied for Apgar calculation such as respiratory rate, crying and heartbeats are related to organ development and in these conditions the relevant organs are not well developed and therefore, the calculated score is estimated low. The difference between results reported by Jeganathan et al.'s study and others could be due to other factors or methodological differences (19). In the present study, there was a significant correlation between placental abruption, maternal anemia before pregnancy, bleeding during pregnancy and lower Apgar score. These factors were also identified as effective factors on Apgar score by other studies (3, 22). Based on the findings of the current study some evaluated factors such as mother's blood group, placenta Previa, meconium excretion, birth order, mother's age at the

first birth, mother's age in marriage, chronic underlying diseases, mother's job, maternal education, infertility, unwanted pregnancy, number of pregnancies, number of deliveries, history of abortion, and stillbirth did not show any significant correlation with neonatal Apgar scores. A study by Souza et al. (2017) from Brazil, a significant correlation between maternal age less than 15 years and an Apgar score less than 7 was revealed (11); however other studies in accordance with our results did not reported any correlation between maternal age and Apgar score. This discrepancy may be associated with method selected for maternal age grouping that was lower than 15 in Souza's study but higher in other studies (23).

Other insignificant factors revealed in the current study were in accordance with reports by other studies for example, Shen's study from Canada (2017), for relationship between low Apgar score and maternal hypertension (24), Eslami et al. (2008), and Zakaria et al. (2010) from Iran, for relationship between type of delivery, meconium excretion and low Apgar score (3, 22). The existence of some factors during or before pregnancy such as chronic diseases, history of abortion, stillbirth, infertility, unwanted pregnancy, pregnancy in older ages, meconium excretion, and placenta Previa have been identified as risk factors for both mother and fetus in health systems (4-7). Though these factors were identified as insignificant factors for direct effectiveness on Apgar score only; however, the presence of some of these factors together may face neonates with adverse outcome as well as lower Apgar score. Comparison the Apgar score between boys and girls did not reveal any significant difference in the current study. In accordance with our findings, most studies have reported no difference for Apgar score between boys and girls (23, 24); however, a study by Sheiner et al. (2007), reported lower Apgar score among

boys than in girls (25), and this discrepancy may be related to the methodology selected in their study. Usually, the incidence of death and other adverse clinical outcomes among boys are more than the girls (17); however, these differences are not significant.

#### 4-1. Study Limitations

This study had some limitations including missing data in some families' health dossiers and hospital documents of infants, inaccessibility to data associated with migrated families.

#### 5- CONCLUSION

Based on the findings of the present study, preterm delivery, low birth weight, twin birth, polytocous, breech presentation, premature rupture of membrane, placental abruption, heart disease, injury during pregnancy and maternal anemia were significantly related to Apgar scores less than 7.

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**7- CONFLICT OF INTEREST:** None.

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