Shiraz E-Med J. 2017 March; 18(3):e44155. doi: 10.5812/semj.44155.

Published online 2017 February 19. **Research Article**

Risk Factors Related to the Neonatal Mortality in Kurdistan Province, Iran: A Population-Based Case-Control Study

Nahid Ghotbi,[1] Mehdi Zokai,[2] Khaled Rahmani,[3,4] Farnaz Zand Vakili,[1] Saide Zandi,[5] Nahid Asadi,[6] Ebrahim Ghaderi,[7] and Majid Mansouri[8,*]

[1]Department of Obstetrics and Gynecology, Kurdistan University of Medical Sciences, Sanandaj, Iran
[2]Senior Executive of Public Health, Kurdistan University of Medical Sciences, Sanandaj, Iran
[3]Department of Epidemiology, School of Public Health, Shahid Behehshti University of Medical Sciences, Tehran, Iran
[4]Department of Community Medicine, School of Health, Kurdistan University of Medical Sciences, Sanandaj, Iran
[5]Student of Medicine, Kurdistan University of Medical Sciences, Sanandaj, Iran
[6]BS of Midwifery, Kurdistan University of Medical Sciences, Sanandaj, Iran
[7]Social Determinants of Health Research Center, Kurdistan University of Medical Sciences, Sanandaj, Iran
[8]Department of Pediatric, Kurdistan University of Medical Sciences, Sanandaj, Iran

[*]*Corresponding author*: Majid Mansouri, Department of Pediatric, Kurdistan University of Medical Sciences, Sanandaj, Iran. Tel: +98-9111762648, E-mail: Magidmansoori@yahoo.com

Received 2016 November 21; **Revised** 2017 January 21; **Accepted** 2017 January 30.

Abstract

Background: Neonatal mortality rate (NMR) is one of the most important health indicators in the world.
Objectives: The current study aimed at determining the factors influencing neonatal mortality in Kurdistan province, Northwest of Iran.
Methods: The current population-based case-control study was conducted in 2013. Cases were neonates who passed away within their first 28 days of life, in Kurdistan. The controls were selected among neonates who were born in the closest time and place to the case group. Data were collected using a questionnaire through interviews by a trained questioner. Chi-square, Fisher exact test, and logistic regression were used to analyze the data. All analyses were conducted by SPSS version 19.
Results: A significant difference was observed between the neonatal mortality and the place of residence, maternal education level, maternal passive smoking, age, neonate birth weight, type of delivery, and nutrition. Maternal passive smoking during the previous year, pregnancy interval of less than 3 years, placental abruption, age, birth weight, malformations, and asphyxia were the most important factors associated with neonatal mortality.
Conclusions: To reduce the NMR, in addition to follow-up *and a*pplication of national guidelines, other necessary factors including the regionalization of the maternal and neonatal cares, planning, and development of programs with the focus on the causes and risk factors of neonatal mortality in Kurdistan province should be considered.

Keywords: Neonatal Mortality, Risk Factor, Case-Control, Kurdistan

1. Background

Neonatal mortality rate (NMR) as an indicator of public health reflects the demographic, biological, cultural, and economic status of the population (1). The NMR also represents the growth trend and public health of the population (2). Reducing the NMR is still an important health topic in the developing countries and it is also the 4th objective of the Millennium Development Goals, which drags huge attentions (3, 4). Neonatal mortality is defined as the death of newborns in their first 28 days of life or the neonatal period (5, 6).

Nearly, 40% of the under-5 mortality occurs within the 28 days of life (7). The rates and causes of the neonatal mortality vary in different regions and states (8). Many previous studies investigated the causes of the neonatal mortality to improve health care and reduce neonate deaths. According to the world health organization (WHO) reports, the leading causes of 80% of all neonatal mortality include prematurity, low birth weight, infections, birth asphyxia, and birth trauma (9, 10). Due to the use of innovative solutions/interventions to prevent and care in many parts of the world, the NMR has decreased (11). Based on the latest reports, the NMR in the world decreased from 33 deaths per 1000 live births in 1990, to 21 deaths per 1000 live births in 2012 (12). In Iran, after the implementation of the integrated children health care programs, the NMR decreased from 26 deaths per 1000 live births in 1990, to 16 per 1000 live births in 2012. This value in Kurdistan province also decreased from 13.5 deaths per 1000 live births in 1990 to 12.2 per 1000 live births in 2012 (13, 14).

Despite efforts to reduce the NMR, its trend is slow and this subject led to an increase in the deaths of children un-

der 5 years old (8); 1 study assessed under-5 mortality rate in Kurdistan province during 2007 to 2011 and showed that the NMR did not have a significant decreasing pattern (14). The current study aimed at investigating the influencing factors on the NMR in Kurdistan province, Iran, in 2013.

2. Methods

The current population-based case-control study was conducted from October to December 2013. Cases were neonates who died within the first 28 days of their lives in Kurdistan province, Iran. Control group was randomly selected from neonates born in the closest time and place to dead neonates. The inclusion criterion was neonatal death within the study period in Kurdistan province. Exclusion criterion for case and control groups was death occurred in the children who came from other parts of Iran to Kurdistan province and died there. Data were collected from the deputy of health and civil registration. In the year of conducting the study, 198 neonates died that based on the inclusion and exclusion criteria, 181 cases were selected as the case group, while 17 neonates were excluded from the study. The control group had twice the size of the case group. After reviewing the literature and national guidelines for maternal death and the neonatal care, the causes of the neonatal mortality were identified by referring to the references and preparing the initial checklist. Data were collected using a checklist contained various questions, including demographic variables, maternal history of diseases, problems during pregnancy and childbirth, and questions related to the neonates. The checklist was checked, revised, and approved by a panel of 3 experts. To determine the reliability of the checklist, it was completed by 2 interviewers with 10 cases in 1 of the health centers. Data were collected by trained interviewers from urban health centers, hospitals (including maternity hospitals), medical records, and interviewing with the parents of neonates in both case and control groups.

Analysis of the data was made by SPSS version 19. First, the univariate analysis was conducted using the Chi-square and Fisher exact test, then, multivariate analysis was performed using logistic regression.

3. Results

Among all mothers, 2 cases (0.04%) gave birth at home. Of all pregnant mothers, 415 (76.4%) were covered by health centers, 124 (22.8%) were visited by private gynecologist and 4 cases (0.7%) were not covered by any health services during pregnancy. The average distance from households to the closest health center in the case and control groups was 15.8 $\pm$ 16.9 and 18.9 $\pm$ 19.3 minutes, respectively. Most of the study participants were Kurdistan province residents. There was a significant difference between the place of residence and the NMR (P = 0.027). A significant association was also observed in the maternal education between the case and control groups (P = 0.04). Most of the neonate deaths were observed among illiterate mothers. Moreover, there were no significant relationships between the case and control groups regarding mother's job (P = 0.7), father's education (P = 0.1), and father's job (P = 0.7) (Table 1).

There were no significant differences between the studied groups regarding unwanted pregnancy, number of pregnancies, pre-pregnancy care, high-risk pregnancy, complete vaccination during pregnancy, exposure to the X-rays during pregnancy, and history of medication during pregnancy. However, there were statistically significant differences in maternal passive smoking (OR = 2.1, P = 0.002), history of neonatal mortality (OR = 3.4, P = 0.005), having prior stillbirths (OR = 5.8, P = 0.002), having prior abortion (OR = 1.6, P = 0.05), and history of hospitalization (OR = 1.7, P = 0.02) between the studied groups. In the case group, mothers were more exposed to passive smoking during pregnancy than the control group. Moreover, the history of stillbirth and hospitalization was higher in the case group (Table 2).

There were statistically significant differences in the history of placental abruption (OR = 13.9, P < 0.001), placenta previa (OR = 8.2, P = 0.045), premature rupture of membranes (PROM) (OR = 2.9, P = 0.02) and difficult childbirth (OR = 3.3, P = 0.03) between the 2 studied groups. The placental abruption, placenta previa, PROM, and difficult childbirth were higher in the case group. A significant difference was also observed in umbilical cord problems between the 2 groups (OR = 6.08, P = 0.1) (Table 3).

The association between problems related to high-risk pregnancy and neonatal mortality is detailed in Table 4. There were no statistically significant associations between the 2 studied groups regarding abnormal body mass index (BMI), pregnancy under 18 years old, first pregnancy (first gravidity), mother's height less than 150 cm, and breastfeeding during pregnancy. In the current study, there were significant associations between the 2 groups regarding pregnancy after 35 years old (OR = 1.79, P = 0.04), pregnancy intervals less than 3 years (OR = 2.5, P = 0.004), 5th and more pregnancies, (OR = 4.6, P = 0.005) and multiple pregnancies (OR = 8.1, P = 0.000). Meanwhile, pregnancy after 35 years, pregnancy intervals of less than 3 years, 5th pregnancy, and multiple pregnancies were higher in the case group (Table 4). No significant association was observed between the mean age of the mothers in the case (232.3 $\pm$ 6.0 years) and control groups (696.3

Table 1. Demographic Characteristics of the Study Cases[a]

Characteristic	Cases (n = 181)	Controls (n = 362)	Total (n = 543)	P Value
City				-
Baneh	13 (7.2)	26 (7.2)	39 (7.2)	
Bijar	11 (6.1)	22 (6.1)	33 (6.1)	
Dehgolan	5 (2.7)	10 (2.7)	15 (2.7)	
Divandareh	7 (3.9)	14 (3.9)	21 (3.9)	
Sarvabad	4 (2.1)	8 (2.1)	12 (2.1)	
Saqqez	35 (19.3)	70 (19.3)	105 (19.3)	
Sanandaj	70 (38.7)	140 (38.7)	210 (38.7)	
Kamiaran	4 (2.1)	8 (2.1)	12 (2.1)	
Qorveh	14 (7.8)	28 (7.8)	42 (7.8)	
Marivan	18 (9.9)	36 (9.9)	54 (9.9)	
Place of residence				0.027
Urban	118 (65.6)	268 (74.7)	386 (71.6)	
Rural	62 (34.4)	91 (25.3)	153 (28.4)	
Father's education				0.12
Illiterate	13 (7.2)	14 (3.9)	27 (5)	
Primary	62 (34.3)	93 (25.7)	155 (28.5)	
Guidance	36 (19.9)	76 (21)	112 (20.6)	
Diploma	46 (25.4)	120 (33.1)	166 (30.6)	
Academic	24 (13.3)	59 (16.4)	83 (15.3)	
Mother's education				0.042
Illiterate	35 (19.3)	34 (9.4)	69 (12.7)	
Primary school	62 (34.3)	129 (35.6)	191 (35.2)	
Guidance school	28 (15.5)	65 (18)	93 (17.1)	
High school diploma	35 (19.3)	70 (19.3)	105 (19.3)	
Higher education	21 (11.6)	64 (17.7)	85 (15.7)	
Father's job				0.7
Employed	172 (95)	341 (94.2)	513 (94.5)	
Jobless	9 (5)	21 (5.8)	30 (5.5)	
Mother's job				0.69
Employed	172 (95)	341 (94.2)	513 (94.5)	
Jobless	9 (5)	21 (5.8)	30 (5.5)	

[a] Value are expressed as No. (%).

$\pm$ 936.5 years), (P = 0.8). Gestational age in the case and control groups was 31.8 $\pm$ 1.7 and 38.7 $\pm$ 5.8 weeks, respectively (P < 0.001). There was a significant difference in the gestational age and birth weight between the groups. In the case group, the mean gestational age, and birth weight were higher than those of the control group.

One hundred and seventy-six (48.6%) neonates in the control group and 181 (44.8%) neonates in the case group were female and the rest were male. There was no significant difference in the neonatal gender between the studied groups (OR = 1.2, P = 0.4). There were statistically significant differences in the birth weight (less and more than 25000 g), type of childbirth (vaginal or cesarean) (P = 0.004, OR = 1.709), type of feeding (breast or formula milk), (OR = 7.9, P < 0.001), sepsis (OR = 0.300, P < 0.001), asphyxia (OR = 174.6, P < 0.001), breathing problems (such as hyaline membrane disease, respiratory distress syndrome, and pneumonia) (OR = 113.9, P < 0.001,), history of hospitalization (OR = 41.8, P < 0.001), medication (OR = 74.4, P < 0.001), birth injuries (OR = 12.4, P = 0.007), and malformations (OR = 19.2, P < 0.000) between the 2 groups. Therefore, the number of caesarean sections, formula milk feeding, sepsis, asphyxia, breathing problems, need for the neonatal resuscitation, hospitalization history, receiving medication, birth injuries, and malformations were higher in the case group than the control group (Table 5). It is noteworthy that after transferring the variables into the logistic regression model, factors associated with the neonatal death were classified into (i) maternal factors and (ii) the neonatal factors (Table 5).

Table 2. Association Between Maternal Factors and Neonatal Mortality[a,b]

Variables	Cases (n = 181)	Controls (n = 362)	OR (95%CI)	P Value
Maternal passive smoking				0.002
No	142 (78.9)	318 (88.8)	2.1 (1.3 - 3.5)	
Yes	38 (21.1)	40 (11.2)		
Unwanted pregnancy				0.52
No	135 (74.6)	280 (77.3)	1.64 (0.8 - 1.8)	
Yes	46 (25.4)	82 (22.7)		
Gender preference				0.2
No	9 (5)	28 (7.8)	1.6 (0.7 - 3.5)	
Yes	171 (95)	332 (92.2)		
Gravidity				0.085
≤ 2	125 (19.1)	275 (76)	1.4 (1.0 - 2.1)	
> 2	56 (30.9)	87 (24)		
History of neonatal mortality				0.005
No	168 (92.8)	354 (97.8)	3.4 (1.4 - 8.4)	
Yes	13 (7.2)	8 (2.2)		
History of Stillbirth				0.002
No	170 (93.9)	358 (98.9)	5.8 (1.8 - 18.5)	
Yes	11 (6.1)	4 (1.1)		
History of abortion				0.047
No	137 (75.7)	300 (82.9)	1.6 (1.0 - 2.4)	
Yes	44 (24.3)	62 (17.1)		
History of hospitalization				0.02
No	136 (75.1)	302 (83.4)	1.7 (1.1 - 2.6)	
Yes	45 (24.9)	60 (16.6)		
Taking pre-pregnancy cares				0.6
No	122 (67.4)	251 (69.3)	1.1 (0.7 - 1.6)	
Yes	59 (32.6)	111 (30.7)		
High-risk pregnancy				0.7
No	38 (21)	72 (19.9)	0.9 (1.6 - 1.5)	
Yes	143 (79)	290 (80.1)		
Complete vaccination during pregnancy				0.4
No	16 (8.8)	25 (6.9)	0.7 (0.4 - 1.5)	
Yes	165 (91.2)	337 (93.1)		
Taking X-rays during pregnancy				1.0
No	177 (97.8)	354 (97.8)	1 (0.3 - 3.4)	
Yes	4 (2.2)	8 (2.2)		
Special medication during pregnancy				0.6
No	150 (82.9)	305 (84.3)	1.1 (0.7 - 1.8)	
Yes	31 (17.1)	57 (15.7)		

[a] Value are expressed as No. (%).
[b] Data were expressed using univariate analysis.

4. Discussion

In 2001, the NMR was 183.3 deaths per 1000 live births in Iran and this rate decreased to 15.3 deaths per 1000 live births, according to the Iran's Multiple-Indicator Demographic and Health Survey (IrMIDHS) report (15). Achieving the Millennium Development Goals to reduce NMRs requires the identification of risk factors associated with the neonatal mortality. The current study attempted to determine factors influencing the NMR in Kurdistan province, Iran.

According to the IrMIDHS report, as well as other related studies, the NMR was higher in rural areas in 2010 (15). In various studies, lack of access to health centers and long distance between health facilities in rural areas were listed as factors influencing the NMR (16, 17). Moreover, pre-

Table 3. Problems Associated with Pregnancy and Delivery[a,b]

Variables	Cases (n = 181)	Controls (n = 362)	OR (95%CI)	P Value
Placental abruption				0.001
No	168 (92.8)	360 (99.4)	13.9 (3.1 - 62.4)	
Yes	13 (7.2)	2 (0.6)		
Placenta previa				0.04
No	177 (97.8)	361 (99.7)	8.2 (0.91 - 73.5)	
Yes	4 (2.2)	1 (0.3)		
Umbilical cord problems				0.01
No	178 (98.3)	361 (99.7)	6.1 (0.6 - 58.9)	
Yes	3 (1.7)	1 (0.3)		
Premature rupture of membranes				0.02
No	171 (94.5)	355 (98.1)	3 (1.1 - 7.9)	
Yes	10 (5.5)	7 (1.9)		
Hard childbirth				0.03
No	173 (94.5)	357 (98.1)	3.3 (1.1 - 10.2)	
Yes	8 (4.4)	5 (1.4)		

[a] Value are expressed as No. (%).
[b] Data were expressed using univariate analysis.

vious studies in rural areas of Iran indicated that the NMR decreased due to the coverage of health services (13, 15). In the present study, the NMR in rural areas was higher than urban areas. In the recent years, the following issues came to light more: Considering the coverage and convenient access to health services in rural areas, improving the quality of maternal and neonatal health care services, application of various approaches focusing on the health services instead of treatment in family physician program, and using the current midwifery personnel after considering in service training.

Several studies investigated the effect of various factors influencing the NMR such as illiteracy, lack of knowledge, and parental employment with the focus on mothers (18, 19). In the current study, the NMR was higher in uneducated mothers. This result was consistent with those of other findings. Results of a national study in 2015 showed that the level of females' health literacy in Kurdistan province was lower than that of the national health literacy (15). Due to the protective effects of mother's education on the NMR (20, 21), more training programs should be provided to improve the neonatal health care in mothers. Also, employed mothers should be encouraged to spend more time before and after childbirth.

Low birth weight is one of the most important factors associated with the NMR in different parts of the world (4, 22, 23), as well as different areas of Iran (24-26). The current study results also showed that low birth weight (less than 2500 g) increases the risk of death in the neonates by 32.6-fold. The prematurity and low birth weight are other important factors influencing the NMR, which in some cases are associated with economic conditions of the family. To prevent the birth of neonates with less than 2500 g weight, increasing the quantity and quality of health care services in the prenatal period and strengthening of nutritional programs for low income pregnant mothers should be considered as a priority (27, 28).

In the current study, various risk factors including history of abortion (with probability of 1.6), stillbirth (with odds ratio of 5.8), and history of hospitalization (with odds ratio of 1.665) increased the risk of neonatal mortality. The occurrence of placental abruption, placenta previa, PROM, and difficult childbirth was higher in the case group. These factors are associated with the quality of prenatal care and emergency midwifery with particular attention to the high-risk pregnancy. Therefore, it is necessary to pay more attention to the organization of structures, standardization of services in high-risk pregnancy centers, and increasing the knowledge and skills in midwifery personnel in the province.

Several studies on the effect of smoking on newborns showed that cigarette smoke (active or passive) competes with oxygen in reaching the fetus (29, 30). This phenomenon causes adverse effect on pregnancy, increases

Table 4. Association Between Neonatal Mortality and Problems Associated with High-Risk Pregnancy[a]

Variables	Cases	Controls	P Value
Abnormal BMI			0.9
No	115 (63.5)	231 (63.8)	
Yes	66 (36.5)	131 (36.2)	
Pregnancy age < 18 years			0.2
No	179 (98.9)	351 (97)	
Yes	2 (1.1)	11 (3)	
Pregnancy age > 35 years			0.04
No	155 (85.6)	331 (91.4)	
Yes	26 (14.4)	31 (8.6)	
First gravidity			0.1
No	117 (65.6)	208 (57.5)	
Yes	64 (35.4)	154 (42.5)	
Pregnancy interval < 3 years			0.004
No	159 (87.8)	343 (94.8)	
Yes	22 (12.2)	19 (5.2)	
Gravidity ≥ 5			0.005
No	170 (93.9)	357 (98.6)	
Yes	11 (6.1)	5 (1.4)	
Mother's height < 150 cm			0.07
No	171 (94.5)	353 (97.5)	
Yes	10 (5.5)	9 (2.5)	
Multiple pregnancy			< 0.001
No	156 (86.2)	355 (98.1)	
Yes	25 (13.8)	7 (1.9)	
Breastfeeding during pregnancy			1.0
No	179 (98.9)	359 (99.2)	
Yes	2 (1.1)	3 (0.8)	

[a]Value are expressed as No. (%).

the costs of health care, sudden death syndrome, and especially low birth weight (31). There was a statistically significant relationship between the passive smoking and NMR. The results of multivariate analysis also showed that passive smoking increased the NMR by 2.121-fold. The effect of smoking on newborn mortality requires further and more complete studies; after inclusion of confounding factors. Pre conception cares for mothers should include dangers of smoking and its high risk in neonatal mortality, the benefits of quitting smoking, and avoidance of smoking. Previous studies reported that maternal age and interval between consecutive births were the effective factors in the NMR (32, 33). Mortality rate in the neonates whose mothers were aged 20-30 years was low, and the interval between the births more than 3 years could reduce the neonatal mortality by 40% (34).

The results of the current study showed that the NMR increased by 1.25-fold in mothers over 35 years. Also, pregnancy interval more than 3 years decreased the mortality rate by 1.25-fold. Regarding the health of mother and child, high rate of fertility is one of the current challenges in Iran. Therefore, the current status of various factors such as increased age of marriage, increased age of the first pregnancy after the marriage, and unwanted pregnancy are considered. To improve maternal and neonatal health, the following points should be emphasized in the educational programs: Marriage at an appropriate age, decreased maternal age of the 1st pregnancy, and increased interval between pregnancies.

Due to its anti-hypothermia and anti-hypoglycemia effects, breastfeeding is one of the most important factors influencing neonatal mortality (35, 36). Breastfeeding is also introduced by WHO as an effective strategy to reduce the mortality rate (37, 38). Moreover, feeding by cow milk is introduced as a risk factor for neonatal mortality in various studies in the world (18, 39). According to the IrMIDHS study, the breastfeeding rate was 53.13% in Iran, and 74.82% in Kurdistan province, in 2010 (15). In this study, feeding method was associated with neonatal mortality. Therefore, the following points play a key role in the improvement of breastfeeding program: Mother's education on the benefits of exclusive breastfeeding in the first 6 months of life, skin to skin contact in the first hours after birth, and allocation of specialized counseling centers.

Normal vaginal delivery in health centers and under the supervision of a trained person may help to prevent birth injuries and complications of the delivery (40). In previous studies conducted in different parts of the world, it was reported that the cesarean was a risk factor for the neonatal mortality (41-43). In Iran, 45.55% and in the Kurdistan province 38.89% of females give birth by caesarean section, while the normal rate of cesarean is 20% to 30% according to the National Health Improving Program (15). In the present study, cesarean section was a risk factor for the neonatal mortality. Therefore, encouraging mothers to natural childbirth in the health center, developing natural childbirth, and eliminating unnecessary cesarean are the priority programs in the healthcare system.

Neonatal mortality rate is higher in males than females. This may be due to immune deficiency, higher prevalence of respiratory problems, infectious diseases, congenital disorders, and urinary system malformations (24, 44). While, there was no difference in healthcare services between both genders. However, various studies re-

Table 5. Results of Logistic Regression to Assess the Association Between Neonatal and Maternal Factors, and Neonates Mortality

Variable	OR (95%CI)	P Value[a]	Variable	OR (95%CI)	P Value[a]
Birth height	1.1 (0.9 - 1.3)	0.4	Passive smoking during pregnancy	2.1 (1.2 - 3.6)	0.006
Gestational age	0.8 (0.6 - 0.9)	0.02	Maternal age < 18 years	0.3 (0.06 -1.9)	0.2
Birth weight	0.9 (0.9 - 1.0)	0.01	Maternal age > 35 years	1.3 (0.6 - 2.6)	0.5
Need to resuscitation	1.7 (0.3 -8.5	0.5	Pregnancy interval < 3 years	2.6 (1.2 -5.7)	0.01
Abnormality	18.5 (2.4 - 140.3)	0.005	Gravidity $\geq$ 5	3.4 (0.9 - 15.6)	0.06
Sepsis	3.10 (0.4 - 24.4)	0.2	First gravidity	1.3 (0.8 - 2.0)	0.2
Asphyxia	7.2 (1.2 - 41.7)	0.02	Mother's height < 150 cm	2.3 (0.8 - 6.2)	0.1
Respiratory problems	3.0 (0.6 - 15.4)	0.2	Multiple pregnancy	11.02 (4.5 - 26.8)	< 0.001
APGAR	2.1 (0.4 - 11.2)	0.4	Pre-eclampsia/eclampsia	4.5 (0.9 - 20.7)	0.05
Hospitalization	2.0 (0.6 - 7.1)	0.3	Dekolman	12.3 (2.5 - 60.0)	0.002
Difficult labor	3.8 (0.02 - 602.3)	0.6	Placenta previa	4.6 (0.4 - 58.3)	0.2
Multiple birth	0.2 (0.02 - 2.5)	0.2	PROM	2.9 (0.9 - 8.8)	0.05

[a] Backward method was used as variable selection method in logistic regression.

ported that gender was another factor affecting the neonatal mortality and the mortality rate was different between the two genders in different regions (7, 8, 45, 46). It was noted that although greater rate of neonatal mortality in males than females was reported in some studies (7, 13), the current study results were consistent with those of the study conducted in Pakistan (10), the neighboring country of Iran.

Although many different factors were implicated based on the geographic region of neonatal death including pneumonia, diarrhea, infection, asphyxia, trauma, sepsis, congenital abnormalities, metabolic disorders, pulmonary hemorrhage, necrotizing enter-colitis, and meningitis (10, 13, 47-53), the main causes of neonatal mortality in Iran were respiratory distress syndrome, congenital anomalies, sepsis, infection, asphyxia, and pulmonary hemorrhage (47).

One of the limitations of the current study was incomplete data on neonatal mortality. However, through contact with the parents and review of other records, the researchers tried to fill the questionnaires and complete the data as much as possible.

In summary, the current study findings could be utilized to determine priorities, planning, evaluating of services, and improving the health care for mothers and the neonates. In the current study, 3 factors including anomalies, asphyxia, and respiratory problems were the main causes of neonatal mortality. Therefore, educational and therapeutic interventions, as well as improvement of structural defects in the body of healthcare system should be a priority for health policy-makers and health providers.

4.1. Conclusion

The current study results showed that several factors such as passive smoking during pregnancy, pregnancy interval < 3 years, multiple pregnancy, dekolman, gestational age, low birth weight, abnormality and asphyxia of neonates were the main factors related to the neonatal mortality in Kurdistan province, Iran. To reduce the NMR in Kurdistan province, in addition to follow-up and application of national guidelines, other necessary factors including regionalization of maternal and neonatal cares, planning, and development of programs with the focus on the above mentioned risk factors should be considered.

Acknowledgments

The manuscript was a part of MD thesis by S. Zandi. The authors would like to thank Kurdistan University of Medical Sciences for the financial support.

Footnote

Conflict of interest: Authors declared no conflict of interest exists.

References

1. Liu L, Oza S, Hogan D, Perin J, Rudan I, Lawn JE, et al. Global, regional, and national causes of child mortality in 2000-13, with projections to inform post-2015 priorities: an updated systematic analysis. *Lancet.* 2015;**385**(9966):430–40. doi: 10.1016/S0140-6736(14)61698-6. [PubMed: 25280870].
2. Flood K, Malone FD. Prevention of preterm birth. *Semin Fetal Neonatal Med.* 2012;**17**(1):58–63. doi: 10.1016/j.siny.2011.08.001. [PubMed: 21893439].
3. Lang CT, Iams JD. Goals and strategies for prevention of preterm birth: an obstetric perspective. *Pediatr Clin North Am.* 2009;**56**(3):537–63. doi: 10.1016/j.pcl.2009.03.006. [PubMed: 19501691].
4. Lederman RP. Preterm birth prevention: a mandate for psychosocial assessment. *Issues Ment Health Nurs.* 2011;**32**(3):163–9. doi: 10.3109/01612840.2010.538812. [PubMed: 21341950].

5. Blencowe H, Calvert Ph DC, Lawn JE, Cousens S, Campbell OM. Measuring maternal, foetal and neonatal mortality: Challenges and solutions. *Best Pract Res Clin Obstet Gynaecol.* 2016;**36**:14–29. doi: 10.1016/j.bpobgyn.2016.05.006. [PubMed: 27439881].
6. McIntire DD, Leveno KJ. Neonatal mortality and morbidity rates in late preterm births compared with births at term. *Obstet Gynecol.* 2008;**111**(1):35–41. doi: 10.1097/01.AOG.0000297311.33046.73. [PubMed: 18165390].
7. Wang H, Liddell CA, Coates MM, Mooney MD, Levitz CE, Schumacher AE, et al. Global, regional, and national levels of neonatal, infant, and under-5 mortality during 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013. *Lancet.* 2014;**384**(9947):957–79. doi: 10.1016/S0140-6736(14)60497-9. [PubMed: 24797572].
8. You D, Hug L, Ejdemyr S, Idele P, Hogan D, Mathers C, et al. Global, regional, and national levels and trends in under-5 mortality between 1990 and 2015, with scenario-based projections to 2030: a systematic analysis by the UN Inter-agency Group for Child Mortality Estimation. *Lancet.* 2015;**386**(10010):2275–86. doi: 10.1016/S0140-6736(15)00120-8. [PubMed: 26361942].
9. Heaman M, Kingston D, Chalmers B, Sauve R, Lee L, Young D. Risk factors for preterm birth and small-for-gestational-age births among Canadian women. *Paediatr Perinat Epidemiol.* 2013;**27**(1):54–61. doi: 10.1111/ppe.12016. [PubMed: 23215712].
10. Jehan I, Harris H, Salat S, Zeb A, Mobeen N, Pasha O, et al. Neonatal mortality, risk factors and causes: a prospective population-based cohort study in urban Pakistan. *Bull World Health Organ.* 2009;**87**(2):130–8. doi: 10.2471/BLT.08.050963. [PubMed: 19274365].
11. Oestergaard MZ, Inoue M, Yoshida S, Mahanani WR, Gore FM, Cousens S, et al. Neonatal mortality levels for 193 countries in 2009 with trends since 1990: a systematic analysis of progress, projections, and priorities. *PLoS Med.* 2011;**8**(8):ee1001080. doi: 10.1371/journal.pmed.1001080. [PubMed: 21918640].
12. Blencowe H, Cousens S, Oestergaard MZ, Chou D, Moller AB, Narwal R, et al. National, regional, and worldwide estimates of preterm birth rates in the year 2010 with time trends since 1990 for selected countries: a systematic analysis and implications. *Lancet.* 2012;**379**(9832):2162–72. doi: 10.1016/S0140-6736(12)60820-4. [PubMed: 22682464].
13. Chaman R, Naieni KH, Golestan B, Nabavizadeh H, Yunesian M. Neonatal mortality risk factors in a rural part of Iran: a nested case-control study. *Iran J Public Health.* 2009;**38**(1):48–52.
14. Rahmani KH, Zokaei M, Bidarpoor F, Babahajiani SH, Nessaei P, Moradi GH. Children mortality rate trend in kurdistan province during 2007 to 2011. *Iranian J Epidemiol.* 2014;**10**(1):65–72.
15. Rashidian A. Health observatory: First report ir. Iran multiple-indicator demographic and health survey 2010 [internet] Tehran: Ministry of health and medical education; 2010. Available from: http://nihr.tums.ac.ir/Images/Archive/fffe97ff-53a0-486a-871d-3a10d48f6a6b.pdf.Persian.
16. Christley RM, Morgan KL, Parkin TD, French NP. Factors related to the risk of neonatal mortality, birth-weight and serum immunoglobulin concentration in lambs in the UK. *Prev Vet Med.* 2003;**57**(4):209–26. doi: 10.1016/S0167-5877(02)00235-0. [PubMed: 12609466].
17. Titaley CR, Dibley MJ, Roberts CL. Type of delivery attendant, place of delivery and risk of early neonatal mortality: analyses of the 1994-2007 Indonesia Demographic and Health Surveys. *Health Policy Plan.* 2012;**27**(5):405–16. doi: 10.1093/heapol/czr053. [PubMed: 21810892].
18. Seedhom AE, Kamal NN. Some determinants of neonatal mortality in a rural area, El-Minia governorate, Egypt, 2008. *Egypt J Community Med.* 2010;**28**(2).
19. Tachiweyika E, Gombe N, Shambira G, Chadambuka A, Mufuta T, Zizhou S. Determinants of perinatal mortality in Marondera district, Mashonaland East Province of Zimbabwe, 2009: a case control study. *Pan Afr Med J.* 2011;**8**:7. doi: 10.4314/pamj.v8i1.71054. [PubMed: 22121416].
20. Adekoya DO, Oni G. Differentials in risk of neonatal mortality among children of young mothers in nigeria: Empirical evidence from ndhs 2013. 2016
21. Das Gupta M. Death clustering, mothers' education and the determinants of child mortality in rural punjab, india. *Popul Stud.* 1990;**44**(3):489–505. doi: 10.1080/0032472031000144866.
22. Epstein MB, Bates MN, Arora NK, Balakrishnan K, Jack DW, Smith KR. Household fuels, low birth weight, and neonatal death in India: the separate impacts of biomass, kerosene, and coal. *Int J Hyg Environ Health.* 2013;**216**(5):523–32. doi: 10.1016/j.ijheh.2012.12.006. [PubMed: 23347967].
23. Kayentao K, Garner P, van Eijk AM, Naidoo I, Roper C, Mulokozi A, et al. Intermittent preventive therapy for malaria during pregnancy using 2 vs 3 or more doses of sulfadoxine-pyrimethamine and risk of low birth weight in Africa: systematic review and meta-analysis. *JAMA.* 2013;**309**(6):594–604. doi: 10.1001/jama.2012.216231. [PubMed: 23403684].
24. Gharavi AGK, Shoraka HR, Sofizadeh A, Katuli HE. Neonatal mortality risk factors in Maraveh Tapeh County in Golestan province, north of Iran (2011-13). *J Gorgan Uni Med Sci.* 2016;**18**(1).
25. Golestan M, Akhavan Karbasi S, Fallah R. Prevalence and risk factors for low birth weight in Yazd, Iran. *Singapore Med J.* 2011;**52**(10):730–3. doi: 10.1016/j.earlhumdev.2008.09.065. [PubMed: 22009392].
26. Jafari F, Eftekhar H, Pourreza A, Mousavi J. Socio-economic and medical determinants of low birth weight in Iran: 20 years after establishment of a primary healthcare network. *Public Health.* 2010;**124**(3):153–8. doi: 10.1016/j.puhe.2010.02.003. [PubMed: 20226486].
27. Hoyme UB, Huebner J. Prevention of preterm birth is possible by vaginal pH screening, early diagnosis of bacterial vaginosis or abnormal vaginal flora and treatment. *Gynecol Obstet Invest.* 2010;**70**(4):286–90. doi: 10.1159/000314019. [PubMed: 21051849].
28. Yoshioka A, Miyachi Y, Imamura S. Mechanisms of reactive oxygen species-induced skin erythema and superoxide dismutase activities in guinea pigs. *J Dermatol.* 1987;**14**(6):569–75. [PubMed: 3329656].
29. Cnattingius S, Haglund B, Meirik O. Cigarette smoking as risk factor for late fetal and early neonatal death. *BMJ.* 1988;**297**(6643):258–61. doi: 10.1136/bmj.297.6643.258. [PubMed: 3416144].
30. Pineles BL, Hsu S, Park E, Samet JM. Systematic Review and Meta-Analyses of Perinatal Death and Maternal Exposure to Tobacco Smoke During Pregnancy. *Am J Epidemiol.* 2016;**184**(2):87–97. doi: 10.1093/aje/kwv301. [PubMed: 27370789].
31. Yerushalmy J. The relationship of parents' cigarette smoking to outcome of pregnancy-implications as to the problem of inferring causation from observed associations. *Int J Epidemiol.* 2014;**43**(5):1355–66. doi: 10.1093/ije/dyu160. [PubMed: 25301860].
32. Selemani M, Mwanyangala MA, Mrema S, Shamte A, Kajungu D, Mkopi A, et al. The effect of mother's age and other related factors on neonatal survival associated with first and second birth in rural, Tanzania: evidence from Ifakara health and demographic surveillance system in rural Tanzania. *BMC Pregnancy Childbirth.* 2014;**14**:240. doi: 10.1186/1471-2393-14-240. [PubMed: 25048353].
33. Schimmel MS, Bromiker R, Hammerman C, Chertman L, Ioscovich A, Granovsky-Grisaru S, et al. The effects of maternal age and parity on maternal and neonatal outcome. *Arch Gynecol Obstet.* 2015;**291**(4):793–8. doi: 10.1007/s00404-014-3469-0. [PubMed: 25227657].
34. Arokiasamy P, Gautam A. Neonatal mortality in the empowered action group states of India: trends and determinants. *J Biosoc Sci.* 2008;**40**(2):183–201. doi: 10.1017/S0021932007002623. [PubMed: 18093346].
35. Edmond KM, Zandoh C, Quigley MA, Amenga-Etego S, Owusu-Agyei S, Kirkwood BR. Delayed breastfeeding initiation increases risk of neonatal mortality. *Pediatrics.* 2006;**117**(3):e380–6. doi: 10.1542/peds.2005-1496. [PubMed: 16510618].
36. Huffman SL, Zehner ER, Victora C. Can improvements in breast-feeding practices reduce neonatal mortality in developing countries?. *Midwifery.* 2001;**17**(2):80–92. doi: 10.1054/midw.2001.0253.

[PubMed: 11399129].
37. Moss W, Darmstadt GL, Marsh DR, Black RE, Santosham M. Research priorities for the reduction of perinatal and neonatal morbidity and mortality in developing country communities. *J Perinatol.* 2002;**22**(6):484–95. doi: 10.1038/sj.jp.7210743. [PubMed: 12168128].
38. Vogel JP, Souza JP, Gulmezoglu AM. Patterns and Outcomes of Induction of Labour in Africa and Asia: a secondary analysis of the WHO Global Survey on Maternal and Neonatal Health. *PLoS One.* 2013;**8**(6):ee65612. doi: 10.1371/journal.pone.0065612. [PubMed: 23755259].
39. Abrams SA, Schanler RJ, Lee ML, Rechtman DJ. Greater mortality and morbidity in extremely preterm infants fed a diet containing cow milk protein products. *Breastfeed Med.* 2014;**9**(6):281–5. doi: 10.1089/bfm.2014.0024. [PubMed: 24867268].
40. Titaley CR, Dibley MJ, Agho K, Roberts CL, Hall J. Determinants of neonatal mortality in Indonesia. *BMC Public Health.* 2008;**8**:232. doi: 10.1186/1471-2458-8-232. [PubMed: 18613953].
41. Althabe F, Sosa C, Belizan JM, Gibbons L, Jacquerioz F, Bergel E. Cesarean section rates and maternal and neonatal mortality in low-, medium-, and high-income countries: an ecological study. *Birth.* 2006;**33**(4):270–7. doi: 10.1111/j.1523-536X.2006.00118.x. [PubMed: 17150064].
42. MacDorman MF, Declercq E, Menacker F, Malloy MH. Infant and neonatal mortality for primary cesarean and vaginal births to women with "no indicated risk," United States, 1998-2001 birth cohorts. *Birth.* 2006;**33**(3):175–82. doi: 10.1111/j.1523-536X.2006.00102.x. [PubMed: 16948717].
43. Malloy MH. Impact of cesarean section on neonatal mortality rates among very preterm infants in the United States, 2000-2003. *Pediatrics.* 2008;**122**(2):285–92. doi: 10.1542/peds.2007-2620. [PubMed: 18676545].
44. Gissler M, Jarvelin MR, Louhiala P, Hemminki E. Boys have more health problems in childhood than girls: follow-up of the 1987 Finnish birth cohort. *Acta Paediatr.* 1999;**88**(3):310–4. doi: 10.1111/j.1651-2227.1999.tb01102.x. [PubMed: 10229043].
45. World Health Organisation. . World Health Organisation: Perinatal Mortality Rate: World Health Organisation; 2006 Available from: http://www.who.int/entity/ceh/indicators/perinatalmortality.
46. Vidaeff AC, Ramin SM. Management strategies for the prevention of preterm birth. Part I: Update on progesterone supplementation. *Curr Opin Obstet Gynecol.* 2009;**21**(6):480–4. doi: 10.1097/GCO.0b013e328332a8a4. [PubMed: 19770761].
47. Hidar Z. Trends in infant mortality and its causes. 2014
48. Arbour MW, Corwin EJ, Salsberry PJ, Atkins M. Racial differences in the health of childbearing-aged women. *MCN Am J Matern Child Nurs.* 2012;**37**(4):262–8. doi: 10.1097/NMC.0b013e31824b544e. [PubMed: 22739483].
49. Carlini L, Somigliana E, Rossi G, Veglia F, Busacca M, Vignali M. Risk factors for spontaneous preterm birth: a Northern Italian multicenter case-control study. *Gynecol Obstet Invest.* 2002;**53**(3):174–80. [PubMed: 12053103].
50. Dolan SM, Callaghan WM, Rasmussen SA. Birth defects and preterm birth: overlapping outcomes with a shared strategy for research and prevention. *Birth Defects Res A Clin Mol Teratol.* 2009;**85**(11):874–8. doi: 10.1002/bdra.20634. [PubMed: 19824057].
51. Ebrahimi S, Haghbin S, Poor-Mahmoodi A. Incidence and etiologic factors of prematurity. *Armaghane-danesh.* 2000;**5**(19-20):41–35.
52. Hoffman HJ, Bakketeig LS. Risk factors associated with the occurrence of preterm birth. *Clin Obstet Gynecol.* 1984;**27**(3):539–52. doi: 10.1097/00003081-198409000-00004. [PubMed: 6541539].
53. Joy S, Rhea DJ, Istwan NB, Desch CN, Stanziano G. The risk for preterm labor in women receiving 17 alpha-hydroxyprogesterone caproate prophylaxis for preterm birth prevention. *Am J Perinatol.* 2010;**27**(4):343–8. doi: 10.1055/s-0029-1243306. [PubMed: 20013580].