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Comparison of Factors Associated with the Neonatal Mortality Rate in Fars Province before and after Implementing the Health Section Evolution: A Retrospective Cross-Sectional Study

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ABSTRACT

Background: The neonatal period or the first 28 days after birth is a critical and vulnerable time for a child period, and the mortality rate is high due to the severe problems which might happen during this period. The goal of this study was to compare the risk factors associated with the neonatal mortality rate (NMR) before and after the implementation of the health sector evolution plan (HSEP) in Fars Province, Iran.

Methods: This study was a retrospective cross-sectional study. This research was conducted using the census method, and 275951 newborns' files were studied. Variables are expressed as percentage and frequency. The chi-square test and Fisher tests was used to measure the significance level of variables. A multivariate logistic regression model was also used to estimate the odds ratio of neonatal mortality and risk factors associated with neonatal mortality. All statistical tests were performed bilaterally with P-value < 0.05 considered as significant. All tests were conducted using the software $SPSS_{19}$.

Results: After HSEP, risk factors of pregnancy and delivery complications were significantly reduced, and abnormalities were significantly increased (P-value < 0.001). Using multivariate logistic regression analysis, the risk of death is nine times more in gestational age below 37 weeks compared to gestational age over 37 weeks. The chances of neonatal mortality among neonates weighing less than 1000 grams are much more, and it is about 140 times more than normal weight (over 2500 grams). There was not a significant relationship between the chance of neonatal mortality and the implementation of HSEP (P-value > 0.05).

Conclusion: Neonates with abnormal weight and premature neonates had the highest chance of death. Therefore, the prevention of preterm labor and low-birth-weight infants are essential factors in reducing neonatal mortality. This study suggests that improved health service quality is determinative to decrease neonatal mortality rate.

Key words: Neonatal mortality, Healthcare reform, Iran

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Introduction

The neonatal period or the first 28 days after birth is a critical and vulnerable time for a child period, and the mortality rate is high due to the severe problems which might happen during this period (1, 2). Therefore, the provision, maintenance, and promotion of neonatal health, as a vulnerable group, in a health care system has a special place, and it is one of the most evident indicators of communities' development (3, 4). The NMR indicates the neonate's death who died from the beginning of the birth to the first 28 days of life, and it is expressed as the death rate per 1,000 live births per year (5). NMR is higher in the early 24 hours of life, which accounts for 65 % of infant's deaths (6). According to the World Health Organization (WHO) report, in 2019, 2440464 infants die in the first 28 days of their lives worldwide. While in Iran, 13075 infants die in the early 28 days of their lives (7). According to the WHO report, the NMR was dropped from 36.6 deaths per 1,000 live births in 1990 to 17.47 deaths per 1,000 live births in 2019. About 52.3 percent decrease was observed during these years (7). Ninety-nine percent of all neonate deaths occur in developing countries, especially in South Asia and sub-Saharan Africa (7). In this regard, Iran is a country with a modest rate of NMR (6). Besides, this indicator has been improved over the past several decades, as if NMR in Iran has been declined from 16.31 per 1000 live births in 2004 to 8.58 per 1,000 live births in 2019 (7). According to the national study on the burden of diseases in Iran, published in 2007, the fourth factor in Iran was reported to be due to diseases and disorders occurring around birth (8). Different factors affect neonatal mortality, which is generally divided into biological and non-biological categories (6). Biological causes include immaturity, infections, and asphyxia at birth. For non-biological reasons of equal importance, socioeconomic status, gender, mother's literacy level can be mentioned (9). According to past researches, on average, 9.6 percent of infants are born preterm universe, and in Iran, the rate is 5.6–13.4 percent (10). Generally, congenital anomalies and diseases related to premature infants are the most common causes of neonatal mortality in most societies (6). According to WHO, premature births (30 %), sepsis or pneumonia (27 %), asphyxia at birth (23 %), congenital malformations (6 %), infantile tetanus (4 %), diarrhea (3 %), and other causes (7 %) are the causes of neonatal mortality (11). According to different Iran studies, various factors are associated with neonatal mortality, such as asphyxia at birth, low birth weight (less than 2500 g), and prematurity (gestational age below 37 weeks) congenital malformations, male gender. Other factors are maternal factors such as chronic diseases, diabetes, and pre-eclampsia, which are the main risk factors for neonatal mortality (12-16). Non-biological causes are equally important, including literacy of mother, socioeconomic status, and gender (6). In the past two decades, due to the health system's inability to meet the new health needs and expectations, a strong international trend was established to reform the health system (17). In early 2014, the Ministry of Health and Medical Education of Iran developed and gradually implemented the plan as the HSEP on eight axes (18, 19). Recently, this plan's effectiveness in controlling mortality rate and other risk factors associated with neonatal mortality is investigated. Therefore, this study was conducted to compare the risk factors associated with neonatal mortality two years before and after implementing HSEP in Fars Province in the southern part of Iran.

Materials and Methods

This retrospective cross-sectional study was carried out between June 2018 and February 2019. The study population enrolled all neonates who were one to 29 days old and hospitalized at all hospitals and birth centers affiliated to Shiraz University of Medical Sciences, Fars Province, Iran. They were examined for four years (2013-2016). The data collection tool was a software called Iranian Maternal and Neonatal network (IMaN). IMaN is one of the bigest sources of data for maternal health and monitoring neonatal. This network registration approximately whole births

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(dead and alive), demographics and maternal and neonatal health data electronically in and out of hospitals Nationwide. Since 2014, IMaN has recorded out of hospital births at maternity and childbirth facilities, homes, or other places. In this network, such data as the demographic characteristics of the newborn's mother, the relation amang parents, mode of delivery, number of gravidity and parity, mother's medical history, abortion history, risk factors for pregnancy and childbirth, gestational weeks, infant's birth characteristics and birthdate (e.g., body weight) are recorded. The neonatal mortality rate was defined as the number of deaths during the first 28 completed days of life per 1000 live births in a year. Risk factors for pregnancy include gestational diabetes, hypertensive, heart disease, autoimmune disease, thyroid disorders, mental illness, drug abuse, hepatitis B, alcohol consumption, pre-eclampsia/ eclampsia, and urinary and fecal incontinence, positive VDRL, and pilo nephrite. The gestational age was based on both the final menstrual period (the distance between the first day of the mother's ultimate usual menstrual period and the date of delivery of the newborn or fetus) and ultrasound. A preterm neonate was distinguished as a neonate that was born before 37 completed weeks of pregnancy. Birth weight less than 1000 grams was considered a very low birth weight, a birth weight of 1000-1500 grams was regarded as very low birth weight, a birth weight of 1500-2500 grams was considered low birth weight, and weight of 2500 grams and above was considered as normal birth weight. Prematurity was defined as a gestational age below 37 weeks.

According to inclusion criteria, all neonates who were one to 29 days old and whose information was recorded in the system and its accuracy was confirmed by the experts of the Children and Neonatal Health Department of Shiraz University of Medical Sciences, entered in the study. Exclusion criteria were also neonates whose data was not recorded in the system or died after 28 days. Also, neonates, who died out of the hospital or died before delivery, were not included in the study. The collected data were then entered into $SPSS_{19}$. To describe the data, percentage and frequency were used, and for analytical description, the chi-square test was used to measure the significance level of variables. The odds ratio and confidence interval were measured. P-value < 0.05 were considered statistically significant. The Ethics Committee approved this study of Shiraz University of Medical Sciences. No.IR.SUMS.REC.1397.635. After explaining the objectives of the project to the Deputy of Treatment of Shiraz University of Medical Sciences, access to the data of this study was given to the researchers through the IMaN system.

Results

A total of 275951 live births and neonatal mortality were 272780 and 3171, respectively. Two years before and after implementing the HSEP, 1562 (11.42 per 1000 births), and 1609 (11.55 per 1000 births) neonatal mortalities were registered. The characteristics of the neonates studied before and after implementing the HSEP are shown in Table 1. The results showed that the neonates' sex ratio was the same before and after implementing the HSEP. Cesarean section was significantly decreased (P-value < 0.001). Although the gestational age and birth weight were significantly increased, it seems that this increase is not considerable. Risk factors for pregnancy and complications of delivery were reduced considerably, and anomalies were increased significantly.

NMR is based on the risk factors measured in Table 2. The total number of neonatal mortality before and after HSEP was 1562 and 1609, respectively, which was not statistically significant. The analysis shows no significant difference between neonate's gender and mortality before and after HSEP. Although the mortality rate was less in the cesarean section before the implementation of HSEP, there was no significant difference between these two variables. NMR before and after HSEP was 20.31 and 18.3 per 1000 births, respectively, in women who gave birth through vaginal delivery. The difference was

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significant. The NMR was significant in women over 37 weeks of pregnancy and below 37 weeks of pregnancy before and after implementation of HSEP, as if in women below 37 weeks of pregnancy, the mortality rate was 60 per 1000 deaths before HSEP which increased to 67 per 1000 deaths after HSEP. However, there was a significant decrease in mortality rate before and after implementation of HSEP in women over 37 weeks of pregnancy. The mortality rate in neonates weighing less than 1000 grams was very high as if before the implementation of HSEP, the rate was 889 per 1000 live births, and after the performance of HSEP, it was 852 per 1000 live births, which showed a significant decrease (P-value < 0.05). There was no significant difference in mortality rate in other weight classes before and after the implementation of HSEP. The mortality rate in neonates who had anomalies and neonatal complications was not significant before and after the implementation of HSEP.

Determining the role of HSEP on neonatal mortality rate:

Considering other neonatal mortality correlations, logistic regression has been used to determine the role of HSEP. The results of this analysis are presented in Table 3. Based on these results, male and female neonates have less chance of death than the unknown gender. Also, cesarean section neonates have less chance of death. The risk of death is nine times more in gestational age below 37 weeks compared to gestational age over 37 weeks. Also, neonatal mortality among neonates weighing less than 1000 grams is much more, and it is about 140 times more than normal weight (over 2500 grams), and the chance of neonatal mortality among neonates weighing between 1000 to 1500 grams is 51.67 times more than normal weight. Anomaly neonates had a 2.54-fold increase in the chance of mortality. Finally, there was not a significant relationship between the chance of neonatal mortality and the implementation of HSEP.

Table 1. Characteristics of the population studied before and after the implementation of the HSEP

Characteristic	Before Health Sector Evolution N/Percent	After Health Sector Evolution N/Percent	Statistical index/Fisher exact test	P
Gender(total)	136663	139288		
Male	70334(51.5)	71432(51.3)	4.53	0.103
Female and Obscure	66329(48.5)	67856(48.7)		
Type of delivery				
Cesarean section	84939(62.2)	76537(54.9)	1474	< 0.001*
Vaginal	51724(37.8)	62751(45.1)		
Gestational age (Mean)(weeks)	38.38 ± 1.73	38.45 ± 1.79	10.65	< 0.001*
< 37 w	22082(16.2)	21201(15.2)	45	< 0.001*
≥ 37 w	114581(83.8)	118087(84.8)	15	< 0.001*
Birth weight(grams) Mean(SD)	3137 ± 494	3166 ± 501	15	< 0.001*
< 1000 g	878(0.7)	999(0.7)		
1000-1500 g	359 (0.3)	311(0.2)		
1500-2500 g	9579(7)	8652(6.2)		
> 2500 g	125847(92.1)	129326(92.8)	65	< 0.001*
Risk factors for pregnancy				
Yes	29228(21.4)	11812(8.5)	90	< 0.001*
No	107435(78.6)	127476(91.5)		
Neonatal anomalies				
Yes	8197(6)	10180(14.3)	4019	< 0.001*
No	128466(94)	60887(85.7)		
Neonatal complications				
Yes	30281(22.2)	5674(4.1)	199	< 0.001*
No	106382(77.8)	133614(95.6)		

N: Number, Statistically significant at P-value < 0.05; No signs: No significance

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Table 2. Neonatal mortality according to measured characteristics

Characteristic	Before HSE: N/Rate(per 1000 births) N = (136663)	After HSE: N/Rate (per 1000 births) N = (139288)	Statistical index	P
Death(total)	1562(11.42)	1609(11.55)	0.09	0.764
Gender				
Male	0.846	0.846	0.846	0.846
Female and Obscure	0.808	0.808	0.808	0.808
Type of delivery				
Cesarean section	0.237	0.237	0.237	0.237
Vaginal	0.023*	0.023*	0.023*	0.023*
Gestational age				
< 37 w	0.002*	0.002*	0.002*	0.002*
≥ 37 w	0.004*	0.004*	0.004*	0.004*
Birth weight				
< 1000 g	0.016*	0.016*	0.016*	0.016*
1000-1500 g	0.069	0.069	0.069	0.069
1500-2500 g	0.073	0.073	0.073	0.073
> 2500 g	0.076	0.076	0.076	0.076
pregnancy Risk factors				
Yes	0.001*	0.001*	0.001*	0.001*
No	0.683	0.683	0.683	0.683
Neonatal complications				
Yes	0.253	0.253	0.253	0.253
No	0.161	0.161	0.161	0.161
Neonatal Anomalies				
Yes	0.125	0.125	0.125	0.125
No	< 0.001*	< 0.001*	< 0.001*	< 0.001*

HSE: Health section evolution. N: Number. g: grams, w: weeks, Statistically significant at P-value < 0.05; No signs: No significance

Table 3. Neonatal mortality correlations

Variable	OR	95 % CI		P
Gender				
	Ref			
Male	0.407	0.187	0.888	0.024*
Female	0.360	0.165	0.787	0.010*
Type of delivery				
	Ref			
Cesarean section	0.300	0.255	0.353	< 0.001*
	Ref			
< 37 w	9.04	7.53	10.85	< 0.001*
	Ref			
< 1000 g	140	116	169	< 0.001*
1000-1500 g	51.67	39.85	67.00	< 0.001*
1500-2500 g	4.94	4.08	5.99	< 0.001*
	Ref			
Yes	1.12	0.90-1.36		0.318
	Ref			
Yes	1.13	0.91	1.41	0.241
	Ref			
Yes	2.54	2.15	2.99	< 0.001*
HSEP	1.06	0.915	1.22	0.439

OR; Odds Ratio, CI: Confidence of interval, HSEP: Health section evolution plan, g; grams, w: weeks, Statistically significant at P-value < 0.05; No signs: No significance

Discussion

Neonatal mortality is a serious concern of the community health in all countries, including developing and developed countries. While the rate of neonatal mortality is decreasing worldwide, this declining change is slow (16). According to our best knowledge, this is the first study that compares the risk factors associated with neonatal mortality before and after the implementation of the HSEP in Iran. A software called IMAN records all birth and neonatal mortality and their risk factors associated with neonatal mortality. The results showed that the cesarean section's rate was significantly decreased compared to the period before implementing the HSEP. It seems that the Ministry of Health has approached one of the goals of the HSEP, which was the promotion of vaginal delivery. However, for more accurate evaluation, these studies should be carried out at different periods to gain more awareness about this trend's continuation. Pregnancy risk factors and delivery complications were significantly reduced compared to the period before the implementation of HSEP. Studies have shown that in case the mortality rate due to infectious factors decreases, the mortality rate will increase due to genetic anomalies. However, the results showed that, generally, NMR was not significantly different before and after the implementation of HSEP. This study showed that there was not a significant difference between neonate's gender and neonatal mortality. Reviewing articles showed different results. While other studies revealed no significant difference between neonate's gender and neonatal mortality (14, 20-22), other studies reported that the mortality rate of male neonates was significantly more than female neonates (6, 23-27). Also, in this study, NMR was significantly less after the implementation of HSEP in women who had a vaginal delivery. While the mortality rate before and after implementation of HSEP was not significantly different in women who had a cesarean section, several studies showed no significant relationship between neonatal mortality and type of delivery (14, 21, 24). Even Babaei's study showed that the cesarean section's mortality rate was significantly more than vaginal delivery (6). Other studies also had similar results (28-30). Our research showed that there is a significant difference between gestational age and neonatal mortality. Other studies' results were similar to our results (6, 21, 23, 24, 31). Regarding high NMR in women with low gestational age, it is important to pay attention to giving proper care during pregnancy and educational interventions in high-risk groups to prevent premature birth. Our research results and other studies revealed a significant relationship between neonatal mortality and neonate birth weight (6, 14, 23, 24). NMR was not significantly different in neonates who had congenital anomalies before and after the implementation of HSEP. In interpreting this finding, it can be said that changes in variables such as congenital anomalies require more time and the completion of the necessary infrastructure, including trained personnel, sufficient diagnostic facilities to diagnose congenital anomalies. However, Oshwandi showed a significant relationship between congenital anomalies and neonatal mortality (14). Findings showed that the unknown gender had a greater chance of mortality than a male and female gender. While in the Subramanian study, male neonates had a higher chance of mortality (32). This study showed that neonates born through cesarean section had significantly less chance of mortality, which was consistent with the results of the research done by Sabzehei et al. (22). Molina et al. (33) also showed the same results. Although, unlike our study, Signore et al. (34) showed that a 1.5-times increased hazard of neonatal mortality after cesarean delivery (both unplanned and planned) compared to vaginal delivery. This study revealed that the chance of neonatal mortality in premature neonates is nine times more. The study carried out by Sabzehei et al. (22) also had the same results. The study's findings conducted by Battin et al. (35) were consistent with our results. Therefore, the role of preventing early childbirth is crucial in controlling neonatal mortality. Comparing the ratio of neonatal mortality and the birth weight showed that neonates with abnormal weight had a very

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high mortality rate. The findings of other studies were similar to the results of this study. Kose Gharavi et al. (23), in their study, stated that birth weight with an odds ratio of 29.6 had the highest effect on neonatal mortality. Furthermore, in the study conducted by Sabzehei et al. (22), neonates' chance of mortality with abnormal weight was significantly more than normal-weight neonates. Therefore, the neonates' birth weight seems to play a critical role in neonatal mortality. Finally, HSEP was considered as a variable and examined the chance of neonatal mortality with HSEP. The results showed no significant relationship between the chances of neonatal mortality and the implementation of HSEP. It seems that more studies are needed at different times so that the HSEP long-term effects can be measured on neonatal mortality. Our research has the benefit of large sample size; however, it has some limitations. First, information on other possible demographic characteristics that could affect survival, such as nutrition status, education level, family income, parental occupation, and insurance status, was lacking. Second, as information were drawn from the cross-sectional study, causal commentary should be made with precaution. Indeed, attribution of causality might be better explored with experimental or longitudinal data.

Conclusion

Neonates with abnormal weight and premature neonates have the highest chance of mortality, and it requires serious attention to prenatal care and delivery and educational interventions for preventing neonatal mortality. It is recommended by planning and performing period pregnancy care, which prevents prematurity and low birth weight of neonates. It also provides sufficient facilities for the maintenance of premature and low birth weight infants, leading to reduced neonatal mortality.

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Conflict of interests

the authors declared no conflict of interests.

Authors' contributions

Alimohammadzadeh Kh, Falahati F, Parsa H, and Karami H designed research; Falahati F, Karami H, and Shirvani M conducted research; Falahati F, Karami H, Shirvani M, Parsa H, Erami A, Eskandari kootahi Z, and Erfani M wrote manuscript. Falahati F had primary responsibility for final content. All authors read and approved the final manuscript.

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