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Causes of Infant Mortality in Babol, Northern Iran

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ABSTRACT

Background and Objective: Infant mortality is an important health indicator. In order to reduce infant mortality, its causes should be considered in each region so that steps can be taken to improve the quality of health care and treatment. Therefore, this study was conducted in order to determine the causes of infant mortality in Babol, northern Iran.

Methods: This cross-sectional study was conducted on all infants who died in public and private hospitals of Babol. The cause of infant death was extracted and analyzed based on the International Classification of Diseases 10th Revision (ICD-10) and also based on laboratory, clinical and paraclinical evidence recorded in the files.

Findings: Out of a total of 16,005 live births in Babol, 123 infants (7.6%) died, of which 53 (43.1%) died in the first 24 hours of life. The mean gestational age of the deceased cases was 31.4±5.5 weeks, the mean birth weight was 1705.4±1045.3 grams, and their mean life span was 5.4±6.6 days. The most common causes of infant mortality were prematurity (30%), congenital anomalies (25.3%), sepsis (17.1%) and respiratory distress syndrome (13%).

Conclusion: The results of the study showed that the most common causes of infant mortality are prematurity and congenital anomalies.

Keywords: *Infant, Mortality, Neonatal Intensive Care Unit, Premature.*

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Introduction

Infant mortality is one of the most important public health problems in the world. This issue is particularly noteworthy in low-income countries (1). The infant mortality rate is an important health indicator that has a direct impact on the mortality rates of infants and children under five years of age (2). According to the World Health Organization (WHO), in the year 2019, 2.4 million infants died worldwide, with approximately 6,700 infant deaths every day, which accounted for 47% of all deaths among children under 5 years of age; about one-third of them died on the day of birth and nearly three-quarters of them died in the first week of life. Children have the highest risk of death in the first 28 days (3). In 2019, Southern and Sub-Saharan Africa had the highest infant mortality rate (27 deaths per 1,000 live births), followed by Central and South Asia (24 deaths per 1,000 live births). Children in these areas are 10 times more likely to die in the first month compared to a child born in a high-income country (3). Infant mortality in Asia account for two-thirds of infant deaths worldwide. The infant mortality rate is considered as one of the basic indicators in the evaluation of the health and hygiene in society and is often used as a standard indicator for the development of health, education and social care systems of a country. The infant mortality rate includes the death of all infants who died from birth to the first 28 days of life and is expressed as the number of deaths per 1000 live births during a year (4). Infant mortality has decreased in the last decade, but the trend of these deaths in Iran is much higher than in developed countries (5). The infant mortality rate in Iran has decreased from 16 per 1000 live births in 2004 to 9.5 per 1000 live births in 2015 (6). The study of infant mortality is useful for improving the health of children and mothers (7). The decrease in infant mortality indicates the improvement of the health status of the society (8).

The causes of infant mortality are generally divided into biological and non-biological categories. Although biological factors such as prematurity, infections and asphyxia at birth are among the known causes of infant mortality, non-biological causes are equally important, which include the socio-economic status, gender and literacy level of the mother (9). According to the report of the World Health Organization in 2019, premature birth, complications related to childbirth (birth suffocation), infections and congenital defects are the most common causes of infant mortality (3). In a study by Altman et al. on infants born at 40 weeks, sudden infant death syndrome was the most common cause of death, which accounted for 39% of all infant deaths. However, birth at 37 weeks increased the risk of death due to infection, cardiovascular disorders, sudden infant death syndrome and malignant neoplasms (10). The most common causes of infant mortality in Ahvaz were prematurity, congenital anomalies, suffocation at birth, and infection (11). Babaei et al. reported the most common causes of infant death to be prematurity, respiratory distress syndrome, and sepsis (12). In the study of Haghshenas Mojaveri et al., sepsis and severe prematurity were reported to be the most common cause of death after the first 24 hours (13). Alimohammadzadeh et al. reported that after the implementation of the health transformation plan, pregnancy risk factors and birth complications decreased, but congenital anomalies increased significantly. Moreover, infants with abnormal weight as well as premature infants had the highest risk of death (14).

The pattern of death in Iran is neither similar to developed countries nor similar to developing countries, but we are in an epidemiological transition. Given the rate of infant mortality in the country and considering that it has a direct effect on the mortality indices of infants and children under 5 years of age and on the other hand, the causes of infant mortality vary according to the level of access to healthcare and quality of healthcare services in different countries, it is absolutely necessary to identify these causes (15). If we intend to take effective steps to reduce infant mortality, the first step is to identify the causes of infant mortality. Understanding the causes of death and modifiable factors associated with death has the potential to reduce infant mortality. Identifying the causes of death in each country or regions of a country is necessary to

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minimize the complications of these programs (16). There is a need to investigate the factors that play a role in reducing the acceleration of infant mortality. Knowledge about the rate and cause of infant mortality is important to choose strategies to further reduce it (17).

Given that the cause of infant mortality in each city and province is different from other provinces and even in different hospitals due to maternal and neonatal factors and is related to factors such as the quality and access to health care in that region, the first step in reducing the mortality rate and improving the level of this index is the identification of the causes of death, and since the rate and causes of death in infants in Babol have not been investigated so far, the present study was conducted to determine the causes of mortality in infants in Babol in 2018-2020.

Methods

after being approved by the research ethics committee of Babol University of Medical Sciences with ethics code MUBABOL.HRI.REC.1395.110, this cross-sectional study was conducted on all infants who died in public and private hospitals of Amirkola, Ayatollah Rouhani, Babol Clinic, Yahyanejad, Day, Valiasr, and Civil Registry Office of Babol between March 21, 2018 and March 19, 2020. All deceased babies born in Babol with a gestational age of more than 23 weeks and a weight of more than 400 grams who died during the first four weeks of birth from March 21, 2018 to March 19, 2020, and the mother's place of residence was Babol and the infants were born there, were included in the study. All deceased babies whose gestational age was less than 23 weeks of pregnancy and their weight was less than 400 grams, the time of their death was more than 28 days, death was due to more than one cause, and mothers from other cities who gave birth in Babol or had another deceased child, were excluded from the study.

After obtaining permission from the medical ethics committee and making arrangements with the hospital officials and the statistics and informatics unit of those centers, the required data were collected based on the documents in the registered files of the infants and a questionnaire was completed for each infant by referring to the archives and medical records unit. The questionnaire included the variables of gender, gestational age, birth weight, type of delivery, age of the infant at the time of death, mother's age, primary diagnosis, cause of infant death, place of delivery and place of death of the infant. The causes of infant mortality were evaluated by two neonatologists based on laboratory, clinical and paraclinical evidence in the medical records and were extracted based on ICD10 code, and considering that autopsy was not performed on patients to determine the cause of death, in cases where the cause of death was not known, these cases were placed in the category of unknown cause of death. Considering that six major causes have been identified for the death of newborns in the birth registration system, which include birth defects, respiratory distress syndrome, hypoxic ischemic encephalopathy (asphyxia), severe prematurity (gestational age less than 26 weeks), infections (sepsis), the extracted causes were categorized in the same way to have a better comparison with the country's situation. Also, by referring to the Civil Registry Office of Babol, data such as the total number of live births by year (2018-2020) and gender were collected and the infant mortality rate was calculated.

The data were entered into SPSS 22. Then, using the descriptive indices of the data, and using ingroup and outgroup chi-square test based on a cross table, the rate and causes of infant mortality were analyzed and $p<0.05$ was considered significant.

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Results

Out of a total of 16,005 live births in Babol from March 21, 2018 to March 19, 2020, 146 cases of infant death occurred, of which 23 cases were excluded from the study due to different reasons. 5 cases of death were over 28 days, 6 cases had more than one cause of death and 12 cases had birth weight less than 400 grams. In general, 123 infants under 28 days in Babol were studied. Among the examined infants, 118 cases (96%) were born in the hospital and 5 cases (4%) in a maternity hospital, and the place of death of all the babies in 123 cases (100%) was in the hospital, and there were no cases of birth or death in the house or other places. The infant mortality rate was 7.6 per 1000 live births.

These infants were born with a mean gestational age of 31.4±5.5 weeks, birth weight 1705.4±1045.3 grams and lived an average of 5.4±6.6 days. The age of their mothers was 27.2±4.9 years. The majority of deceased infants were male, aged 24 hours or less, gestational age between 26-36 weeks, weight less than 1000 grams, and were born by cesarean section ($p<0.05$) (Table 1). The most common causes of infant mortality in Babol include: prematurity in 37 cases (30%), congenital anomalies in 31 cases (25.3%), and sepsis in 21 cases (17.1%) (Table 2).

Table 1. Neonatal and maternal variables in deceased infants

Variable	Total number of deaths(%)	p-value
Gender		
Girl	46(37.4)	
Boy	75(0.61)	0.002
Gender ambiguity	2(1.6)	
Age of the infant (days)		
24 hours and lower	53(43.1)	
2-7	32(26)	0.008
8-28	38(30.9)	
Gestational age (weeks)		
25 and lower	25(20.3)	
26-36	61(49.6)	<0.001
37 and higher	37(30.1)	
Baby's weight (grams)		
Less than 1000	49(39.8)	
1000-2499	40(32.5)	<0.001
2500 and more	34(27.6)	
Mother's age (years)		
Less than 25	49(39.8)	
25-34	66(53.7)	0.757
35 and more	8(6.5)	
Type of delivery		
Cesarean section	70(56.9)	0.049
Natural	53(43.1)	

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Table 2. The frequency of the main causes of infant mortality in Babol in 2018-2020 compared to the country's statistics in 2019

Reported cases Main causes of death	All cases in this study Number(%)	All cases of the country in 2019 Number(%)
Respiratory Distress Syndrome (RDS)	16(13)	6892(31)
Asphyxiation	5(4.1)	1316(6)
Congenital anomalies	31(25.3)	3742(17)
Prematurity	37(30)	5314(24)
Sepsis	21(17.1)	1713(8)
Other causes	13(10.5)	3159(14)
Total	123(100)	22492(100)

The highest and lowest frequencies of death were due to prematurity in 28 cases (57.1%) in infants weighing less than 1000 grams and 2 cases (5.9%) in infants weighing more than 2500 grams and this relationship was statistically significant (p<0.001). The most common cause of death of infants in the first 24 hours was related to prematurity in 29 cases (54.7%), while in infants older than one day, the cause of death was related to congenital anomalies, and this relationship was significant (p=0.008).The most common cause of death in girls and boys was prematurity, but the least common cause in girls was respiratory distress syndrome and in boys was asphyxia, although this relationship was not statistically significant (Table 3).

In mothers under 25 and over 35, the most common cause of infant death was prematurity. In the case of mothers between 25-34 years old, the most common causes of death were related to congenital abnormalities and prematurity. The result of the Chi-square test shows that there is a significant relationship between the causes of death and the gestational age of the mother; the highest rate of infant mortality was at 25 weeks and lower with the cause of death due to prematurity in 19 cases (76%) and the lowest rate of infant mortality was seen in infants who died due to asphyxia in the age range of 26-36 weeks (p<0.001) (Table 4).

Table 3. Correlation between causes of death and neonatal variables in deceased infants

Causes of death Neonatal variables	Respiratory distress syndrome	Asphyxia	Congenital anomaly	Prematurity	Sepsis	Other causes	p-value*
Gender							
Girl	2(4.3)	3(6.5)	13(28.3)	15(32.6)	8(17.4)	5(10.9)	0.309
Boy	14(18.7)	2(2.7)	17(22.7)	22(29.3)	13(17.3)	7(9.3)	
Weight (g)							
<1000	6(12.2)	0	4(8.2)	28(57.1)	7(14.3)	4(8.2)	
1000-2500	10(25)	0	12(30)	7(17.5)	8(20)	3(7.5)	<0.001
>2500	0	5(14.7)	15(44.1)	2(5.9)	6(17.6)	6(17.6)	
Age at death (day)							
≤24 hours	5(8.9)	4(7.1)	9(16.1)	29(58.1)	8(14.3)	1(1.8)	
2-7	5(15.6)	1(3.1)	10(31.2)	4(12.5)	6(18.8)	6(18.8)	<0.001
8-28	6(17.1)	0	12(34.3)	4(10.5)	6(17.1)	6(17.1)	

*The numbers in the table are the number(%) and the presented p-value is the result of the Chi-square test.

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Table 4. Correlation between the causes of death and maternal variables in deceased infants

Causes of death / Maternal variables	Respiratory distress syndrome	Asphyxia	Congenital anomaly	Prematurity	Sepsis	Other causes	p-value*
Gestational age (week)							
≤25	3(12)	0	1(4)	19(76)	1(4)	1(4)	
26-36	11(8.9)	1(0.8)	14(11.3)	17(13.8)	12(20.3)	6(10.2)	<0.001
≥37	2(5.4)	4(10.8)	16(43.2)	1(2.7)	8(21.6)	6(16.2)	
Mother's age (year)							
<25	8(16.3)	2(4.1)	10(20.4)	14(28.6)	10(20.4)	5(10.2)	
25-34	7(10.6)	1(1.5)	20(30.3)	20(30.3)	11(16.7)	7(10.6)	0.95
≥35	1(12.5)	0	1(12.5)	3(37.5)	2(25)	1(12.5)	
Delivery type							
C. section	12(17.1)	2(2.9)	21(30)	12(17.1)	13(18.6)	10(14.3)	0.008
Natural	4(7.5)	3(5.7)	10(18.9)	25(47.2)	8(15.1)	3(5.7)	

*The numbers in the table are the number(%) and the presented p-value is the result of the Chi-square test.

Discussion

In this study, 123 (7.6%) infant deaths occurred in Babol from March 21, 2018 to March 19, 2020. Moreover, the most common causes of infant mortality were prematurity (30%), congenital anomalies (25.3%), sepsis (17.1%) and respiratory distress syndrome (13%). A study conducted in Tabriz by Zeinalzadeh et al. had a similar result of 7.5% (18). In the study of Maleki Jamasbi et al., the mortality rate of newborns in the Neonatal Intensive Care Unit (NICU) of Hamedan was reported to be 5.05 (5). In the study of Haghshenas Mojaveri et al. regarding the mortality rate of infants admitted to the NICU of Ayatollah Rouhani Hospital of Babol, 276 infants out of 4029 admitted cases (6.7%) were reported dead (13) and the results are similar to this study. In the study of Kose Gharavi et al., the infant mortality rate in the years 2011, 2012, and 2013 was reported as 11.76, 13.36, and 6.46 per 1000 live births, respectively (19). The infant mortality rate in Imam Reza Hospital in Kermanshah in 2013-2015 was 19.2% per year (20), which is higher than our study. Perhaps one reason for the difference is the presence of two NICU centers for Inborn and Outborn cases. On the other hand, due to the different time frame of the investigation, and also due to the different maternal and neonatal factors, it seems that the pattern of infant mortality rate in different regions of Iran and even in different hospitals is different.

The most common causes of infant mortality in Babol were prematurity (30%), congenital anomalies (25.3%), sepsis (17.1%) and respiratory distress syndrome (13%). However, in the study of Haghshenas Mojaveri et al., only one special care center for newborns in Ayatollah Rouhani Hospital of Babol was examined from 2007 to 2017. The most common causes of death in newborns were sepsis flowed by disseminated intravascular coagulation (33.4%), severe prematurity less than 26 weeks (18.4%), birth defects (14.8%), and respiratory distress syndrome (14.1%) (13). Therefore, evaluation of the causes of infant mortality in one center compared to all hospitals (public and private) in Babol may reveal different results in terms of infant mortality rate.

In a study in Kermanshah, the most common causes of death were respiratory distress syndrome (33.6%), sepsis (22.6%) and congenital anomalies (8.3%) (12). Furthermore, in another study in Ahvaz, the most common causes of infant mortality were respiratory distress syndrome, septicemia, suffocation, and intracranial bleeding (20). The above studies were not consistent with our study. The most common causes of death in infants investigated in Babol are different from the whole country. In the whole country,

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respiratory distress syndrome is the most common cause of infant death, while in this study it is ranked fourth. It seems that appropriate treatment measures such as non-invasive methods of respiratory support and timely use of surfactant have been able to significantly reduce the death rate caused by respiratory distress syndrome in Babol.

Prematurity had the first rank in Babol and second rank in the whole country, which shows that premature infants have the highest probability of death. Therefore, preventing premature birth and improving the quality of health services in the entire country will be essential factors in reducing infant mortality. One of the reasons for the higher frequency of sepsis in Babol may be due to the fact that in these centers, all suspected cases of infection (presence of clinical symptoms with increased inflammatory markers), despite negative blood cultures, are considered as the cause of death from sepsis. Considering that it is not possible to obtain a positive blood culture from a newborn in many centers due to inadequate laboratory diagnosis facilities, in cases that are clinically suggestive of sepsis or subjects show high levels of C-Reactive Protein and other inflammatory markers, neonatologists have to consider sepsis as the cause of death in cases of infant death. Congenital anomalies were the second most common cause of infant mortality in Babol and the third most common in the country. In a study by Aramesh et al. in Ahvaz, congenital anomalies were the second cause of infant mortality (11), which is consistent with this study. However, in the study of Michel et al. in the US, congenital abnormalities, brain injuries and infections were the most common causes of death of infants in NICU departments with a frequency of 50%, 13% and 8%, respectively (21). In other words, the main cause of infant death in the US in all periods was congenital anomalies, which is not consistent with the findings of the present study. The reason for the difference can be the lack of careful and sufficient attention to examinations at birth and the discovery of anomalies, and the failure to perform paraclinical procedures such as echocardiography of the heart, kidney ultrasound, and failure to perform an autopsy in dead infants (22).

The average life span of the dead infants was approximately 5 days, and 43.1% died in the first 24 hours, and this indicates their clinical deterioration. In the study of Maleki Jamasbi et al., it was also shown that 17.43% of the deaths of infants were in the age group of one day old (5). However, the study of Babaei et al showed that 79.9% of babies died during the first week after birth, which is not in line with the results of the present study (12).

In the present study, 61% of the dead infants were boys and 37.4% were girls. In a study by Maleki Jamasbi, 53.2% of dead infants were boys (5). The same finding was also observed in the study of Monsef et al.; in the study of 195 cases of infant death in NICU, 53% of cases of death occurred in boys and 47% of cases occurred in girls (23). Vu et al. reported that mortality was higher in males (24).

The most common cause of death of infants in the first 24 hours is prematurity (54.7%), while in infants older than one day, the cause of death is related to congenital anomalies. In the study of Baqui et al., the most common causes of death on the first day were asphyxia and birth injury (31%) and premature birth (26%). Between the first and sixth days, the most common causes of death were prematurity (30%) and sepsis (25%) (25).

The highest frequency of deaths related to prematurity (57.1%) was seen in infants weighing less than 1000 grams, which was statistically significant. In the study of Alijani Ranani et al., more than half of the dead infants were premature and underweight, and nearly 55% of them had a very low birth weight (less than 1500 grams) (20). Alimohammadzadeh et al. reported that the probability of death in infants weighing less than 1000 grams is much higher and is about 140 times higher than infants with normal weight. Infants with abnormal weight and premature infants had the highest chance of death (14).

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The highest rate of infant mortality in 25 weeks and lower due to prematurity was 76%, and there is a significant difference between the gestational age and the death of infants. The results of other studies were similar to our results (12, 19). In a study, the risk of death at a gestational age of less than 37 weeks was reported to be 9 times higher than that of a gestational age of more than 37 weeks (14).

One of the limitations of this research is that the information recorded in the patients' files was used to conduct it, which can reduce the value of the analyzed data due to the retrospective nature and the defects in the filing.

The results of this study showed that the rate and causes of infant mortality in Babol are acceptable compared to the whole country. The treatment of respiratory distress syndrome (RDS) is more favorable than the whole country. Considering the factor of prematurity as the most important determining factor of neonatal mortality, it is possible to play an effective role in prevention of premature birth by increasing the quality of care during pregnancy and preventing premature births and the correct implementation of educational intervention programs for high-risk groups. Preparing the medical team for the birth of a premature infant and equipping the NICU in terms of facilities and treatment facilities can be an effective help in reducing the infant mortality rate. It is also necessary to follow the preventive programs of congenital abnormalities (counseling before marriage, before and during pregnancy and diagnosis in families with a history of previous genetic diseases) and sepsis with more seriousness.

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