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ARTICLE

Incidence of Congenital Anomalies and Related Factors in Newborns: A Prospective Study

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ABSTRACT: Introduction: The occurrence of congenital anomalies is one of the serious challenges in the world. Therefore, identifying related factors to reduce it is of particular importance. This study aimed to determine the incidence and factors related to congenital anomalies. **Methods:** An epidemiology study was conducted on 1567 infants and their parents in Kermanshah, Iran. The required information was extracted from the files of mothers in health centers. The data collection tool was a researcher-made checklist of 39 questions. The data was statistically analyzed with the STATA version 14 software. **Result:** The incidence of congenital anomalies was 2.9% (n = 45). Brain anomalies (n = 10) and pulmonary anomalies (n = 8) were the most common congenital anomalies in newborns. The results showed that parents' age ($p = 0.001$), place of residence ($p = 0.022$), mother's occupation ($p = 0.010$), hemoglobin level ($p = 0.002$), blood pressure disorders ($p = 0.001$), bleeding during pregnancy ($p = 0.001$), infection during pregnancy ($p = 0.001$), multivitamins ($p = 0.002$) and women's previous birth records such as previous abnormal birth history ($p = 0.015$), abortion history ($p = 0.001$), stillbirth history ($p = 0.001$), birth history of infant less than 2500 g ($p = 0.001$) was found to have a statistically significant relationship with congenital anomalies. **Conclusion:** The incidence of congenital anomalies was high in Kermanshah city. Considering the identification of risk factors and preventive factors related to congenital anomalies, it is suggested that interventions be carried out in health centers to increase awareness among pregnant women to reduce the incidence of anomalies.

KEYWORDS: Congenital anomalies; infants; brain anomalies; skeletal anomalies; cardiac anomalies

1 Introduction

Congenital anomalies in infants and children are one of the global challenges [1]. Structural anomalies or functional anomalies are defined as congenital anomalies [1]. Congenital anomalies occur at the time of conception or during intrauterine growth [1,2]. Congenital anomalies are detected in one of the stages before birth, at birth, or in the later stages of life [1]. According to the World Health Organization report, three million infants are born with congenital anomalies every year [2]. However, the main cause of death of more than four thousand children in the world is congenital anomalies [2]. The most important cause of disability and death of infants in developed and developing countries is the incidence of congenital anomalies [3]. Incidence of

congenital anomalies in Sweden 3.5%, Paris 3.3%, Egypt 2.5%, China 1.5%, England 8.7%, and Iran 2.3% [3–5]. On the other hand, the increasing trend in the incidence of congenital anomalies causes an increase in abortion, stillbirth, infant death, and disability in children. Therefore, it imposes a huge cost on the healthcare system for hospitalization, treatment, and rehabilitation of patients [2,6]. Therefore, it is important to identify and evaluate factors related to congenital anomalies to reduce treatment and rehabilitation in different geographical locations. Of course, the cause of congenital anomalies is multifactorial [3]. Factors such as heredity, chromosomal disorders, genetics, environment, teratogens (mother suffering from diabetes, high blood pressure, infections, contact with radioactive materials, contact with chemicals, malnutrition, hyperthermia, addiction, etc.) micronutrient deficiency or their interaction affects the development of congenital anomalies. However, more than half of the factors causing congenital anomalies are unknown [2,7]. The present study was conducted to determine the incidence and investigate the related and known factors of congenital anomalies.

2 Methods

2.1 Study Design

The study was epidemiology. We used the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines to report the results of the study [8].

2.2 Samples and Sampling Method

The study population was women who gave birth from 22 May to 21 November 2023 in one of the hospitals of Kermanshah City (Imam Reza, Hazrat Masoumeh, Moatazedi, and Sajad Hospitals), Iran. The intended outcome in the present study was the presence or absence of congenital anomalies in newborns for 30 days. To identify the status of infants (have/don't have congenital anomalies), they were followed up through phone calls recorded in the mothers' files. All infants and their mothers were included in the study by census method. Pregnant women whose fetuses were aborted for any reason or had stillbirths were excluded from the study.

2.3 Instruments

The data collection tool was a researcher-made checklist containing 39 questions. The checklist has 9 individual questions (parents' age, parents' education, father's occupation, place of residence, cousin marriage), 12 pregnancy questions (unintended pregnancy, hemoglobin at the 26–30 weeks of pregnancy, blood pressure disorders, urinary tract infections, bleeding during pregnancy, number of pregnancies, type of delivery, take iron, multivitamins, folic acid, receiving radiation and treatment of infertility), 10 questions related to infants (type of abnormality, sex of infants, the weight of infants) and 8 questions were related to mothers' records (history of abortion, number of births, history of abnormal blood pressure, history of underlying diseases (heart, kidney, lung)).

2.4 Data Collection

The required information was collected from the mothers' files in the health center of Kermanshah City. For infants who had congenital anomalies, a telephone interview was conducted with the parents of the infants to ensure the existence and type of the anomalies. Newborns with

congenital anomalies were classified into four categories: brain anomalies, cardiac anomalies, lung anomalies, and skeletal anomalies.

2.5 Statistical Analysis

Data were analyzed using descriptive and inferential statistics with STATA version 14 software. Frequency, percentage, mean, and standard deviation were used in the descriptive statistics. In the inferential statistics section, a simple logistic regression model was fitted to determine the odds of congenital anomalies based on independent variables (individual questions, pregnancy history questions, and maternal history questions). Then a multiple regression model was performed for the variables with $p < 0.25$. A significance level of less than 0.05 was considered.

3 Result

The present study was conducted on 1567 infants and their parents. The incidence of congenital anomalies was 2.9% (n = 45). 22.2 percent (n = 10) of the infants have congenital brain anomalies. 17.8% (n = 8) of congenital pulmonary anomalies. 8.9% (n = 4) of congenital heart anomalies and 2.2% (n = 1) had congenital skeletal anomalies (Table 1).

Table 1: Descriptive information related to the type of congenital anomalies.

Type of Congenital Anomalies	Total (n = 1567)	Total (n = 45)
Brain	10 (0.6)	10 (22.2)
Lung	8 (0.5)	8 (17.8)
Cardiac	4 (0.3)	4 (8.9)
Skeletal	1 (0.1)	1 (2.2)
Other⁺	22 (1.4)	22 (48.9)
No congenital anomalies	1522 (97.1)	-

Note: ⁺Other: Any abnormality except cerebral, cardiac, skeletal, and pulmonary abnormalities was classified as other. Others include: Down's syndrome, cleft lip or palate, clubfoot, etc.

The results in Table 2 showed that the age of the father and the age of the mother of the infants who had congenital anomalies were 35.5 $\pm$ 5.2 years and 29.7 $\pm$ 6.3 years, respectively. The difference between the average age of parents in infants with congenital anomalies and infants without congenital anomalies was statistically significant ($p = 0.001$). 77.6% (n = 1216) of mothers were employees. 3.5% (n = 42) of the employees and 0.9% of the housewives had infants with congenital anomalies. A statistically significant relationship was found between mothers' occupation and congenital anomalies of newborns ($p = 0.010$). 54.3% (n = 851) of mothers lived in the city, of which 3.8% (n = 32) had infants with congenital anomalies. Only 1.8% (n = 13) of the mothers who lived in the village experienced a baby with a congenital anomaly. Place of residence has a statistically significant relationship with congenital anomalies ($p = 0.022$) (Table 2).

The results in Table 3 showed that 31.9% (n = 500) of mothers had a serum level of hemoglobin $\geq$10.5 at 30–36 weeks. Congenital anomalies of infants in mothers with serum hemoglobin $\geq$10.5 were at least 1.38 times higher ($p = 0.002$). 20.0% (n = 313) of mothers had urinary tract infections during pregnancy. The odds ratio of congenital anomalies of infants in mothers with urinary tract infections was 8.75 times higher ($p = 0.001$). The results showed that 95.5% (n = 1488) of mothers took multivitamins during pregnancy. The odds ratio of congenital anomalies in mothers with the use of multivitamins is 73% lower than the others ($p = 0.001$). (Table 3)

Table 2: Descriptive information about parents and newborn infants (n = 1522).

Variable	Total n = 1567	Infants' Congenital Anomalies		*p*
		No (n = 1522, 97.1%)	Yes (n = 45, 2.9%)	
Information about the father of the infants				
Father's age	28.9 ± 4.7	28.7 ± 4.5	35.5 ± 5.2	<0.001*
Father's education				
Illiterate	802 (51.2)	775 (96.6)	27 (3.4)	0.108**
Diploma	538 (34.3)	529 (98.3)	9 (1.7)	
Bachelor and above	227 (14.5)	218 (96.0)	9 (4.0)	
Information about the mother of the infants				
Mother's age	26.1 ± 4.4	25.9 ± 4.3	29.7 ± 6.3	<0.001*
mother's occupation				
Housewife	351 (22.4)	348 (99.1)	3 (0.9)	0.010**
Employee	1216 (77.6)	1174 (96.5)	42 (3.5)	
mother's education				
Illiterate	892 (56.9)	869 (97.4)	23 (2.6)	0.687**
Diploma	346 (22.1)	334 (96.5)	12 (3.5)	
Bachelor and above	329 (21.0)	319 (97.0)	10 (3.0)	
Residence				
City	851 (54.3)	819 (96.2)	32 (3.8)	0.022**
Village	716 (45.7)	7093 (98.2)	13 (1.8)	
Parents' cousin's marriage				
No relatives	715 (45.6)	698 (97.6)	17 (2.4)	0.237**
Distant relatives	578 (36.9)	562 (97.2)	16 (2.8)	
Close relatives	274 (17.5)	262 (95.6)	12 (4.4)	
Information about the infants				
Infante's sex				
Boy	970 (61.9)	936 (96.5)	34 (3.5)	0.056**
Girl	597 (38.1)	586 (98.2)	11 (1.8)	
Baby's birth weight (grams)	2996.8 ± 448.4	3008.7 ± 4.33.6	2594.5 ± 698.3	<0.001*
Baby's height at birth (cm)	48.9 ± 4.2	49.0 ± 4.1	45.9 ± 4.8	<0.001*

Note: *independent sample *t*-test, **chi-square test, Significance level 0.05.

Table 3: Descriptive information and factors related to congenital anomalies related to mothers during pregnancy (n = 1522).

Variable	Total n (%)	Congenital Anomalies	Unadjusted Model		Adjusted Model	
			OR (95% CI)	*p*	OR (95% CI)	*p*
Unintended pregnancy						
No	1338 (85.4)	37 (2.8)	1 (Ref.)	0.543	1 (Ref.)	0.988
Yes	229 (14.6)	8 (3.5)	1.27 (0.58, 2.77)		1.01 (0.25, 4.02)	
Hemoglobin week 26–30						
<10.5	1067 (68.1)	21 (2.0)	1 (Ref.)	0.002	1 (Ref.)	
≥10.5	500 (31.9)	24 (4.8)	2.51 (1.38, 4.55)		3.42 (1.38, 8.51)	0.008

Table 3: *Cont.*

Variable	Total n (%)	Congenital Anomalies	Unadjusted Model		Adjusted Model	
			OR (95% CI)	*p*	OR (95% CI)	*p*
Blood pressure disorders						
Normal	1008 (64.3)	24 (2.4)	1 (Ref.)		1 (Ref.)	
Hypertension	78 (5.0)	14 (17.9)	8.97 (4.42, 1817)	0.001	9.80 (2.83, 33.94)	0.001
Preeclampsia	481 (30.7)	7 (1.5)	0.60 (0.25, 1.41)	0.247	0.36 (0.08, 1.69)	0.196
Diabetes						
No	1529 (97.6)	42 (2.7)	1 (Ref.)	0.074	1 (Ref.)	
Yes	38 (2.4)	3 (7.9)	3.03 (0.89, 10.26)		3.53 (0.53, 23.35)	0.191
Urinary infection						
No	1254 (80.0)	15 (1.2)	1 (Ref.)	0.001	1 (Ref.)	
Yes	313 (20.0)	30 (9.6)	8.75 (4.64, 16.49)		2.62 (1.65, 9.09)	0.001
Bleeding during pregnancy						
No	1540 (98.3)	38 (2.5)	1 (Ref.)	0.001	1 (Ref.)	
Yes	27 (1.7)	7 (25.9)	13.83 (2.52, 34.68)		3.18 (5.47, 21.48)	0.001
Number of pregnancies						
First pregnancy	794 (50.7)	24 (3.0)	1 (Ref.)		1 (Ref.)	
2–4	486 (31.0)	17 (3.5)	1.16 (0.62, 2.19)	0.640	1.02 (0.58, 2.01)	0.830
≥5	287 (18.3)	4 (1.4)	0.45 (0.16, 1.32)	0.146	0.83 (0.08, 2.28)	0.238
Type of delivery						
Cesarean	18 (1.1)	2 (11.1)	1 (Ref.)	0.051	1 (Ref.)	
Natural	1549 (98.9)	43 (2.8)	0.23 (0.05, 1.02)		0.05 (0.01, 0.71)	0.027
Taking Iron						
No	23 (1.5)	7 (30.4)	1 (Ref.)	0.058	1 (Ref.)	
Yes	1544 (98.5)	38 (2.5)	0.06 (0.02, 0.15)		4.25 (1.89, 5.97)	0.005
Taking multivitamins						
No	79 (5.0)	7 (8.9)	1 (Ref.)	0.002	1 (Ref.)	
Yes	1488 (95.0)	38 (2.6)	0.27 (0.12, 0.62)		0.14 (0.03, 0.73)	0.020
Taking folic acid						
No	71 (4.5)	4 (5.6)	1 (Ref.)	0.163	1 (Ref.)	
Yes	1496 (95.5)	41 (2.7)	0.47 (0.16, 1.36)		0.24 (0.04, 1.36)	0.102
Receive radiation[+]						
No	1403 (89.5)	37 (2.6)	1 (Ref.)	0.110	1 (Ref.)	
Yes	164 (10.5)	8 (4.9)	1.89 (0.87, 4.14)		5.35 (1.73, 6.52)	0.004
Infertility treatment						
No	1542 (98.4)	43 (2.8)	1 (Ref.)	0.141	1 (Ref.)	
Yes	25 (1.6)	2 (8.0)	3.03 (0.69, 13.26)		1.13 (0.08, 6.160)	0.927

Note: [+]Radiation: Receiving radiation includes all radiological procedures such as jaw and face, lung, spine, etc. The multiple logistic regression model was adjusted by adjusting the variables of mother's age, family marriage, and mother's occupation, Significance level of 0.05.

The results of the adjusted logistic regression model showed that the odds ratio of congenital anomaly was 1.69 ($p = 0.001$) times higher in females who had a history of abortion. Also, the odds ratio of congenital anomalies in mothers who had a history of stillbirth was 2.67 ($p = 0.001$) times higher and the history of giving birth to a baby weighing less than 2500 g was 2.09 ($p = 0.001$) times higher (Table 4).

Table 4: Descriptive information related to the records of mothers before pregnancy (n = 1522)

Variable	Total	Infante with Congenital Anomalies		*p*	Adjusted Model	
		No (n = 1522, 97.1%)	Yes (n = 45, 2.9%)		OR (95% CI)	*p*
Did you have a history of anomalies in previous deliveries?						
No	1552 (99.0)	1509 (97.2)	43 (2.8)	0.015	1 (Ref.)	
Yes	15 (1.0)	13 (86.7)	2 (13.3)		3.03 (0.47, 9.53)	0.244
Do you have a family history of congenital anomalies?						
No	1550 (98.9)	1507 (97.2)	43 (2.8)	0.027	1 (Ref.)	
Yes	17 (1.1)	15 (88.2)	2 (11.8)		0.43 (0.04, 4.41)	0.478
Do you have a history of abortion?						
No	1478 (94.3)	1449 (98.0)	29 (2.0)	<0.001	1 (Ref.)	
Yes	89 (5.7)	73 (82.0)	16 (18.0)		1.69 (1.36, 2.09)	0.001
Did you have a history of stillbirth?						
No	1560 (99.6)	1519 (97.4)	41 (2.6)	<0.001	1 (Ref.)	
Yes	7 (0.4)	2 (42.9)	4 (57.1)		2.67 (2.23, 3.44)	0.001
Did you have a history of infant death after birth?						
No	1525 (97.3)	1485 (97.4)	40 (2.6)	0.006	1 (Ref.)	
Yes	42 (2.7)	37 (88.1)	5 (11.9)		4.27 (0.92, 9.83)	0.064
Did you have a history of giving birth to a baby weighing less than 2500 g?						
No	1527 (97.4)	1494 (97.8)	33 (2.2)	<0.001	1 (Ref.)	
Yes	40 (2.6)	28 (70.0)	12 (30.0)		2.09 (6.95, 5.07)	0.001

Note: Chi-square test, the multiple logistic regression model was adjusted by adjusting the variables of mother's age, family marriage, and mother's occupation, Significance level of 0.05.

4 Discussion

According to the results of the present study, the incidence of congenital anomalies was 2.9%. Based on this, the incidence of congenital anomalies in Kermanshah, Iran was higher than in the cities of Birjand (0.5%) [9], Sistan and Baluchestan (1.8%) [10], and Hamedan (2.8%) [11] in Iran. However, its incidence was lower than in Rasht, Iran (4.2%), Sweden 3.5%, Paris 3.3%, and England 8.7% [3–5,12]. The difference in the incidence of congenital anomalies in different parts may be due to different study methods, environmental indicators, genetic indicators, the method of evaluating newborns, and the difference in diagnosis methods for the type of anomalies. In addition, stillbirths and abortions for fetal anomalies can affect the incidence.

In the present study, the most common types of congenital anomalies were brain and lung anomalies. The study by Morris et al. [13–17] reported brain and lung anomalies more than other anomalies. The results of this study were a summary of the prevalence of congenital anomalies in Kermanshah. Therefore, it is suggested to conduct a more comprehensive study on other anomalies.

The findings of the present study indicate that a statistically significant correlation was observed between the weight of the newborn and congenital anomalies. The results of the study indicate that a statistically significant correlation was observed between the infant's weight and congenital anomalies. The results were consistent with the study of Pabbati et al. [18–20]. An infant's weight is directly related to their health. A healthy infant has normal weight and height growth [18–20].

Therefore, low birth weight may be caused by congenital anomalies. Therefore, more studies are needed in this field.

The results of the present study showed that there is a statistically significant relationship between congenital anomalies and the increasing age of pregnant mothers, in general, infants whose mothers were older were at a higher risk for congenital anomalies. The results agreed of the study with the study of Ahn et al. [21–25]. There are several biological mechanisms for the increased risk of congenital anomalies with increasing maternal age. Mechanisms that contribute to increased risk include increased incidence of aneuploidy with age, accumulation of environmental exposures, and increased risk of comorbidities such as diabetes, hypertension, and lipids, also following government policies increases the risk of congenital anomalies.

In the present study, a statistically significant relationship between mothers' occupation and place of residence (urban/rural) and congenital anomalies. These results were aligned with the study of Mekonnen et al. [26–30]. The results may be caused by occupational exposure to environmental toxins or urban pollution. Of course, as pollution levels rise in major cities around the world, we are likely to face even greater challenges in this regard. It is clear that environmental chemicals are harmful to fetal development, and this is a key public health challenge facing health professionals worldwide. However, health professionals alone may have limited ability to develop interventions or find solutions to prevent exposure to toxic chemicals during pregnancy. Therefore, to prevent exposure to toxins during pregnancy, extensive interventions by governments and politicians are needed. It is suggested to carry out more sensitive studies on exposures in different job categories.

The findings of the present study showed that urinary infection increase the probability of congenital anomalies. The results of the present study were aligned with the study of Chughtai et al. [31–34]. Infections are the result of infectious agents such as viruses, viroid, prions, bacteria, etc. The infection leads to the release of inflammatory mediators, after which prostaglandins are produced and matrix-degrading enzymes are stimulated. Stimulation of enzymes leads to the discharge and Rupture of water bag and can eventually lead to various anomalies. Consequently, pregnant women should be aware of this risk and use vaccines and other preventive measures to protect against infectious diseases during pregnancy.

The results indicate that there is a significant relationship between congenital anomalies and hemoglobin disorders. The results of the study by Davidson et al. [35–38] showed that hemoglobin disorders increase the risk of congenital anomalies. Hemoglobin disorders can be controlled with access to glucose-lowering drugs. A healthy lifestyle and health literacy during pregnancy can prevent hemoglobin disorders and subsequent congenital anomalies.

The findings of the study showed that there was a statistically significant relationship between bleeding during pregnancy and congenital anomalies. The results were consistent with the study of Gernsheimer [39] and Orgul [40]. Maternal and fetal risks, along with specific care considerations at various stages of pregnancy, delivery, and after childbirth, need to be taken into account. Early diagnosis and proper management are crucial to avoiding unwanted outcomes, so with careful planning and specialized care from an experienced team, congenital anomalies can be prevented.

In the present study, the consumption of iron, multivitamins, and folic acid reduces the possibility of congenital anomalies. A statistically significant relationship was shown between folic acid consumption and congenital anomalies. The results were consistent with the results of the

study of Zhang et al. [36,41,42]. Taking folic acid before and in the first trimester of pregnancy has been shown to be effective in preventing congenital anomalies. Therefore, implementing mandatory folic acid fortification policies is an important and effective strategy to avert congenital anomalies. Additionally, pregnant women should be advised to supplement with enough folic acid to lower the prevalence of these defects.

5 Limitations

One of the limitations of the present study was the lack of cooperation of the samples in completing the checklist. To overcome this limitation, we tried to gain the trust of the samples by providing evidence and documentation that the plan had been approved by Kermanshah University of Medical Sciences. Another limitation of the present study was the short period. This limitation needs to be taken into account in future studies.

6 Conclusion

The rate of congenital anomalies we found in this study was higher than in other studies conducted in Iran. To help reduce the incidence of these anomalies, it's important to take measures like preventing infections and bleeding during pregnancy, keeping an eye on hemoglobin levels around 26–30 weeks, and monitoring serum iron levels throughout pregnancy. It's also recommended to implement educational interventions at health service centers to inform women before and during pregnancy, especially those with a history of abortion, stillbirth, or giving birth to infants weighing less than 2500 g.

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Availability of Data and Materials: Data available on request from the authors.

Ethics Approval: The study was approved by the Ethics Committee of Kermanshah University of Medical Sciences with the code IR.KUMS.REC.1402.013. Written informed consent was obtained from all participants. All experimental protocols involving human subjects adhered to the relevant national/international/institutional guidelines or the declaration of Helsinki.

Conflicts of Interest: The authors declare no conflicts of interest to report regarding the present study.

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