

Epidemiology of Congenital Anomalies in Iran

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Abstract:

Introduction & Objective: Congenital abnormalities are of the main causes of death and disability in children, infants and neonates in most countries in the world where a remarkable part of these disorders can be prevented with timely measures. The aim of this study was to provide the epidemiological characteristics of congenital anomalies in Iran.

Materials & Methods: This cross sectional investigation was conducted on neonates of the birth year of 2016 in six major geographical regions in Iran including Tehran (capital), East Azerbaijan (northwest), Isfahan (center), Khuzestan (southwest), Sistan and Baluchistan (southeast) and Fars (south) Iran. Congenital defects were classified according to the coding system of the International Classification of Diseases (ICD_10). The sources of ascertainment of congenital defects were records of the cases diagnosed with birth defects, and hospital discharge forms. Fully trained and supervised data officers including midwives, nurses and medical coders were assigned to collect and management of the data for this investigation.

Results: The prevalence of congenital anomalies in Tehran was estimated at 163.2, East Azerbaijan 356.4, Isfahan 326.0, Khuzestan 94.3, Sistan and Baluchistan 264.1, and Fars 376.0 per 10,000 births. The prevalence of major defect groups of genital organs, limb anomalies and heart defects were ranked the first, second and third, respectively, in the country. Hydrocele, undescended testicle and club-foot were the most common anomalies diagnosed in the organs in the study regions.

Conclusions: Congenital anomalies are considerably prevalent in Iran, and it is estimated more than 100.000 cases of birth defects occur annually in the country. It seems, therefore, necessary to develop and implement new methods of screening procedures before, during and after birth to avoid occurring congenital anomalies in the country.

Key Words: Congenital Anomalies, Birth Defects, Prevalence, Iran

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Background and Objective

Congenital anomalies, as defined by the World Health Organization, encompass a spectrum of structural, metabolic, and functional disorders that manifest during intrauterine life, subsequently impairing the normal physiological functions of the body.¹ These anomalies encompass chromosomal, metabolic, and hereditary disorders. Congenital defects are categorized into two primary classifications based on their severity: major and minor. They represent one of the foremost causes of morbidity and mortality among children, infants, and newborns on a global scale. Each year, an estimated 3 to 8 million infants worldwide are diagnosed with congenital anomalies.¹⁻⁵ In Iran, the reported incidence of congenital anomalies exhibits considerable variation, with rates ranging from 10 per 1,000 births in northern regions to 28 per 1,000 births in Yazd.^{6,7} According to the Congenital Anomaly Registration Program in Tabriz (TRoCA), the overall prevalence of congenital anomalies in northwest Iran is estimated at 2.6%.^{8,9}

Epidemiological studies suggest that, in the absence of effective screening and prevention initiatives, approximately 100,000 infants with congenital anomalies are born annually in Iran.^{5,8} The objective of this study is to elucidate the epidemiological characteristics of congenital anomalies at the national level in Iran.

Materials and Methods

Iran comprises 31 provinces, characterized by a rich tapestry of ethnic, religious, and cultural diversity, and is home to refugees from various nations, including Afghan refugees from the east and Iraqi refugees from the west.

This study employed a cross-sectional design, focusing on infants born in the year 1395 (2016-2017) across six distinct regions of Iran: Tehran (the capital), East Azerbaijan (northwest), Isfahan (central), Khuzestan (southwest), Sistan and Baluchestan (southeast), and Fars (southern Iran).

Data were sourced from the maternal and infant hospital information registration systems of hospitals affiliated with medical universities in each of the six regions. All infants born in these hospitals underwent comprehensive routine assessments, examinations, and follow-ups conducted by pediatricians and neonatology specialists to monitor their health status and identify any congenital anomalies until their discharge. Demographic information and details regarding congenital defects were systematically recorded using a pre-designed electronic checklist. The classification of congenital defects was executed in accordance with the International Classification of Diseases (ICD-10) system.

To minimize variations in the measurement of variables and to mitigate random and systematic errors, all professionals involved—including pediatricians, neonatology specialists, midwives, nurses, and experts in disease registration and classification—received standardized training and instructions. All infants whose mothers resided in the designated provinces were included in the study. For the purpose of calculating prevalence rates, infants with multiple congenital anomalies were counted only once. The prevalence of various types of congenital anomalies, along with a 95% confidence interval, was determined by dividing the number of cases within each anomaly group by the total number of infants born.

This study obtained ethical approval from the Ethics Committee of Shahid Beheshti University of Medical Sciences (ethics code IR.SBMU.RETECH.REC.1396.175) and was centrally managed by Mofid University.

Findings

During the year 1395 (2016-2017), a total of 138,643 infants were born in the regions encompassed by this study. As detailed in Table 1, approximately 97% of the births were singleton. Among the mothers surveyed, 28.65% were in families with their spouses.

Table 1- Basic information of participants

Variable	Classification	Frequency	Percentage
<i>Multiples</i>	<i>Singleton</i>	113506	96.96
	<i>Twins</i>	3340	2.85
	<i>Triplet</i>	127	0.11
	<i>Multiple</i>	90	0.08
	<i>Total</i>	117063	100
<i>Relationship</i>	<i>No</i>	77078	71.35
	<i>Yes</i>	30948	28.65
	<i>Total</i>	108026	100
<i>Sex of the newborn</i>	<i>Male</i>	71104	51.25
	<i>Female</i>	67624	48.74
	<i>Gender ambiguous</i>	8	0.01
	<i>Total</i>	138736	100
<i>Condition of birth</i>	<i>Alive</i>	135859	97.93
	<i>Dead</i>	2877	2.07
	<i>Total</i>	138736	100
<i>Type of delivery</i>	<i>Natural</i>	70293	50.67
	<i>Cesarean</i>	68443	49.33
	<i>Total</i>	138736	100
<i>Need for examination by a specialist</i>	<i>Yes</i>	1948	1.75
	<i>No</i>	109490	98.25
	<i>Total</i>	111438	100
<i>*Birth weight (grams)</i>		3002.1	97
<i>*Birth height (centimeters)</i>		46.74	2.74
<i>*Head circumference at birth (centimeters)</i>		32.3	2.7

* Average and standard deviation

presented with ambiguous genitalia. Cesarean sections accounted for 49.33% of the deliveries. The average birth weight of the infants was 3,002 grams (with a standard deviation of 97 grams), and the average height was 46.74 centimeters (with a standard deviation of 2.74 centimeters). Notably, 1.75% of the infants required additional examinations beyond the standard assessments conducted by specialists.

For a total of 3,458 infants, a primary diagnosis of congenital anomalies was documented. The overall prevalence of congenital anomalies was determined to be 249.4 per 10,000 births (95% CI: 241.2-257.6). Among the provinces, Khuzestan exhibited the lowest prevalence of congenital anomalies at 94.3 per 10,000 births (95% CI: 83.6-105.6), whereas Fars province recorded the highest prevalence at 376.0 per 10,000 births (95% CI: 350.9-401.1). The prevalence of congenital anomalies in the provinces of Tehran, East Azerbaijan, Isfahan, and Sistan and Baluchestan was estimated at 163.2 (95% CI: 147.9-178.5), 356.4 (95% CI: 325.1-387.7), 326.0 (95% CI: 304.9-347.0), and 285.9 (95% CI: 242.5-285.8) per 10,000 births, respectively.

As detailed in Table 2, the most frequently reported congenital anomaly pertained to defects of the reproductive system. Limb defects and cardiac anomalies ranked second and third, with prevalences of 31.35 (95% CI: 31.26-31.44) and 18.81 (95% CI: 18.72-18.90) per 10,000 births, respectively. The lowest prevalence was noted for anal region anomalies, at 2.25 (95% CI: 2.16-2.34) per 10,000 births, while genetic defects exhibited a prevalence of 2.88 (95% CI: 2.79-2.97) per 10,000 births. In the provinces of East Azerbaijan, Isfahan, Tehran, and Fars, the predominant congenital anomalies were related to defects of the reproductive system. Conversely, in Khuzestan, the most prevalent anomalies were associated with defects of the skull, fontanelles, and urinary system, with prevalences of 1.42 (95% CI: 1.41-1.43) and 1.07 (95% CI: 1.06-1.08) per 10,000 births, respectively.

The gender distribution indicated that 51.25% of the infants were male, while 0.01%

Table 2 - The most common congenital anomalies in Iran (prevalence per 10,000 births)

Defect location	Tehran		Isfahan	
	Number	Prevalence*	Number	Prevalence*
Abdominal wall defects	2	0.75(0.74-0.76)	23	8.4(8.01-8.79)
Anal defect	1	0.38(0.37-0.38)	15	5.48(5.09-5.87)
Chest defects	6	2.26(2.13-2.39)	23	8.4(8.01-8.77)
Digestive system defects	4	1.51(1.37-1.64)	50	18.26(17.87-18.63)
Genetic defects	5	1.88(1.75-2.01)	4	1.46(1.07-1.83)
Genital defects	96	36.18(36.05-36.31)	340	124.2(123.81-124.57)
Head, neck and face defects	25	9.42(9.09-9.75)	64	23.38(23-23.76)
Heart defects	48	18.09(17.76-18.42)	44	16.07(15.68-16.44)
Organ defects	66	24.88(24.55-25.21)	132	48.22(47.83-48.61)
Skull and cranial defects	26	9.8(9.47-10.13)	52	18.99(18.60-19.38)
Spin and spinal cord defects	4	1.51(1.18-1.84)	12	4.38(3.9-4.77)
Urinary tract defect	16	6.03(5.7-6.36)	32	11.69(11.30-12.09)
Skin defect	10	3.77(3.44-4.10)	104	37.99(37.60-37.38)

* The values in parentheses are the ninety-five percent confidence limits.

Table 2 continued - The most common congenital anomalies in Iran (prevalence per 10,000 births)

Defect location	Khuzestan		Sistan and Baluchestan	
	Number	Prevalence*	Number	Prevalence*
Abdominal wall defects	1	0.36(0.35-0.37)	3	1.42(1.37-1.47)
Anal defect	0	0	2	0.95(0.9-1)
Chest defects	2	0.76(0.75-0.77)	6	2.84(2.79-2.89)
Digestive system defects	0	0	1	0.47(0.42-0.52)
Genetic defects	0	0	3	1.42(1.37-1.47)
Genital defects	0	0	17	8.05(8.01-8.11)
Head, neck and face defects	1	0.36(0.35-0.38)	12	5.69(5.64-5.74)
Heart defects	1	0.36(0.35-0.38)	8	3.79(3.74-3.84)
Organ defects	1	0.36(0.35-0.38)	26	12.32(12.28-12.38)
Skull and cranial defects	4	1.42(1.41-1.43)	12	5.68(5.64-5.74)
Spin and spinal cord defects	0	0	1	0.47(0.42-0.52)
Urinary tract defect	3	1.07(1.06-1.08)	1	0.47(0.42-0.52)
Skin defect	0	0	7	3.32(3.27-3.37)

* The values in parentheses are the ninety-five percent confidence limits.

Table 2 continued - The most common congenital anomalies in Iran (prevalence per 10,000 births)

Defect location	Fars		East Azerbaijan		Total	
	Number	Prevalence*	Number	Prevalence*	Number	Prevalence*
Abdominal wall defects	14	6.33(5.39-7.27)	16	11.85(11.37-12.33)	59	4.25(4.18-4.34)
Anal defect	7	3.16(2.22-4.1)	10	7.4(6.92-7.97)	35	2.25(2.16-2.34)
Chest defects	30	13.55(12.61-14.49)	20	14.8(14.33-15.29)	87	6.27(6.18-6.36)
Digestive system defects	2	0.9(0-1.84)	28	20.73(20.25-21.21)	85	6.12(6.04-6.22)
Genetic defects	2	0.9(0-1.84)	26	19.25(18.77-19.73)	40	2.88(2.79-2.97)
Genital defects	245	102.69(109.75-111.63)	149	110.3(109.82-110.78)	847	61.05(60.96-61.14)
Head, neck & face defects	95	42.92(41.98-43.86)	48	35.54(35.06-36.02)	245	17.66(17.57-17.66)
Heart defects	104	46.98(46.05-47.93)	56	41.47(40.99-41.95)	261	18.81(18.72-18.90)
Organ defects	138	62.35(61.41-63.29)	72	53.31(52.83-53.79)	435	31.35(31.26-31.44)
Skull & cranial defects	79	35.69(34.75-36.63)	63	46.45(46.17-47.13)	236	17(16.92-17.10)
Spin & spinal cord defects	38	17.17(16.23-18.11)	9	6.66(6.12-7.08)	64	4.6(4.51-4.69)
Urinary tract defect	11	4.97(4.03-5.91)	26	19.25(18.77-19.73)	89	6.41(6.33-6.51)
Skin defect	17	7.68(6.74-8.62)	13	9.62(9.15-10.11)	151	10.88(10.79-10.97)

* The values in parentheses are the ninety-five percent confidence limits

In Sistan and Baluchestan province, limb defects and reproductive system defects were the most frequently reported anomalies.

Table 3 presents the prevalence of congenital anomalies categorized according to the ICD-10 system. Among the minor congenital anomalies, hydrocele, undescended testicle, and clubfoot were the most prevalent, with rates of 20.14%, 15.99%, and 13.98%, respectively.

Discussion

Cross-sectional studies serve as vital instruments for establishing baseline data and identifying potential causative factors for diseases at the population level. The present study aimed to ascertain the prevalence of congenital disorders in Iran and to elucidate certain epidemiological characteristics thereof. The overall prevalence of congenital anomalies in Iran was reported as 249.4 per 10,000 births. In comparison, the congenital anomaly registry in Europe indicates a considerable variation in prevalence, ranging from a low of 109 per 10,000 births in Portugal to a high of 368 per 10,000 births in Wales.³ According to the congenital anomaly registry program in Tabriz, the prevalence in Northwestern Iran is estimated at 262.9 per 10,000 births.⁸ In a study conducted by Mekonnen and colleagues, an overall prevalence of 62 per 10,000 births was reported in Ethiopia.¹⁰ Similarly, Abu and

colleagues estimated the prevalence of congenital anomalies in the same African population to be 280 per 10,000 births.¹¹

It is essential to acknowledge that the scarcity of reliable data on the prevalence of congenital anomalies in less developed nations has contributed to the presumption that limited access to screening technologies and early diagnostic capabilities results in elevated prevalence rates in these regions compared to their more developed counterparts. Therefore, when interpreting the occurrence of congenital anomalies in low-income countries and comparing them with other regions, one must consider the potential for underreporting that may arise from inefficient diagnostic approaches and less robust data management practices.

Based on the findings of this study, the most frequently reported congenital anomaly pertained to defects in the reproductive system. Limb defects and congenital heart anomalies ranked second and third in prevalence throughout the country. While defects of the reproductive system were predominant in most regions examined, Khuzestan province demonstrated a higher prevalence of congenital anomalies associated with skull and cranial defects, as well as urinary system defects.

Globally, congenital heart defects, chromosomal abnormalities, and limb defects are among the most commonly observed congenital anomalies,

whereas anomalies related to the ear, face, neck, and respiratory system tend to be less prevalent. However, the specific prevalence of these anomalies varies significantly across different countries and regions, with Iran being no exception to this trend.^{4,5,12-20}

Table 3 - Common minor abnormalities

<i>Congenital anomaly</i>	<i>Frequency</i>	<i>Percentage</i>
<i>Hydrocele</i>	291	20.14
<i>undescended testicle</i>	231	15.99
<i>clubfoot</i>	202	13.98
<i>hypospadias</i>	153	10.59
<i>vascular nevus</i>	103	7.13
<i>polydactyly</i>	63	4.36
<i>Absence of the atrial septum</i>	52	3.60
<i>Cleft palate</i>	47	3.25
<i>Congenital hydronephrosis</i>	47	3.25
<i>Cleft lip</i>	44	3.04
<i>Skull structural abnormalities</i>	30	2.08
<i>Hydrocephalus</i>	27	1.87
<i>Down syndrome</i>	26	1.80
<i>Esophageal atresia</i>	24	1.66
<i>Obstructive anus</i>	24	1.66
<i>Diaphragmatic hernia</i>	23	1.59
<i>Structure of the genital tract</i>	23	1.59
<i>Syndactyly</i>	20	1.38
<i>Meningomyelocele</i>	15	1.04

The disparities in the prevalence of congenital anomalies across various regions can be attributed to a multitude of factors, including differences in diagnostic confirmation processes, coding practices, data collection methodologies, handling of stillbirth cases, and the individual competencies of the healthcare personnel involved, including specialists, nurses, midwives, and medical records staff in the regions studied.

The results of this study further indicate that the majority of recorded congenital anomalies were observed in male infants. Supporting these findings, Aldwick and colleagues reported that males are 1.2 times more likely to present with congenital anomalies as compared to females.²¹ Similarly, Asimi and colleagues found a higher prevalence of congenital anomalies among male newborns.²²

Limitations

Despite being the first national study to estimate the prevalence of congenital anomalies in Iran, this research has its limitations, as is the case with any study. The first limitation pertains to the methodology; being a cross-sectional study, it does not facilitate an examination of temporal trends in the prevalence of congenital anomalies. The second limitation concerns the absence of molecular and cytogenetic diagnostic methods, as well as the lack of autopsy options for stillbirths and neonatal deaths, which may have contributed to the underreporting of cases in this study. To mitigate these limitations and reduce random and systematic errors, all professionals involved—including pediatric and neonatology specialists, midwives, nurses, and disease registration and classification experts—received standardized guidelines and training.

Conclusion

This study provides essential data for understanding the health implications of congenital anomalies in Iran, pending the establishment of a robust registry system for these conditions. The findings indicate a significant prevalence of congenital anomalies, with over 100,000 new cases added to the national population each year.^{5,8} Considering that more than 70% of congenital anomalies are preventable, the development and implementation of modern screening methods

in Iran is imperative. Furthermore, the results can be utilized to design and evaluate screening systems for congenital anomalies during the prenatal and neonatal periods, particularly targeting high-risk groups and regions.

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Conflict of Interest

All authors declare that there are no conflicts of interest regarding the publication of this article.

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References:

- World Health Organization, (Feb. 2023). Congenital anomalies fact sheet [Online]. Available <https://www.who.int/news-room/fact-sheets/detail/birth-defects>.
- International Clearinghouse for Birth Defects Surveillance Research (ICBDSR) (Feb. 2023). Birth Defects Prevalence [Online]. Available: <http://www.icbdsr.org/resources/annual-report>.
- European network of registries for the epidemiologic surveillance of congenital anomalies (EUROCAT) (Feb. 2023). Available: https://eu-rd-platform.jrc.ec.europa.eu/eurocat/eurocat-data/prevalence_en.
- Kouame BD, N'guetta-Brou IA, Kouame GSY, Sounkere M, Koffi M, Yaokreh JB, Odehouri-Koudou T, Tembely S, Dieth GA, Ouattara O. Epidemiology of congenital abnormalities in West Africa: results of a descriptive study in teaching hospitals in Abidjan: Cote d'Ivoire. *African Journal of Paediatric Surgery*. 2015; 12(1): 51-55.
- Christianson A, Howson CP, Modell B. March of Dimes global report on birth defects: the hidden toll of dying and disabled children. March of Dimes Birth Defects Foundation; 2006. Available from: https://dev.marchofdimes.org/materials/global-report-on-birth-defects-the-hidden-toll-of-d2unzZI5_VWOaLZnw6iHcx7hbpMWtWzTuIOU3DabcVY.pdf.
- Vatankhah S, Jalilvand M, Sarkhosh S, Azarmi M, Mohseni M. Prevalence of Congenital Anomalies in Iran: A Review Article. *Iran J Public Health*. 2017; 46(6): 733-743.
- Zahed Pasha Y, Vahedi A, Zamani M, Alizadeh-Navaei R, Zahed Pasha E. Prevalence of Birth Defects in Iran: A Systematic Review and Meta-Analysis. *Arch Iran Med*. 2017; 20(6): 376-385.
- Tarighat F, Golshan E, Dastgiri S. Prevalence of congenital anomalies in the northwest of Iran. *Depiction of Health*. 2021; 12(4): 417-425.
- Stone DH, Dastgiri S, Heidarzadeh M, Abdollahi HM, Imani S, Maher MH. Uses, limitations, and validity of a registry of congenital anomalies in Iran: a critical review. *Journal of environmental and public health*. 2017; 6972617.
- Mekonnen D, MollaTaye, Worku W. Congenital anomalies among newborn babies in Felege-Hiwot comprehensive specialized referral hospital, Bahir Dar, Ethiopia. *Scientific Reports*. 2021; 11(1): 11027.
- Obu HA, Chinawa JM, Uleanya ND, Adimora GN, Obi IE. Congenital malformations among newborns admitted in the neonatal unit of a tertiary hospital in Enugu, South-East Nigeria-a retrospective study. 2012; 10(5): 177.
- Kancherla V, Sundar M, Tandaki L, Lux A, Bakker MK, Bergman JE, Bermejo-Sánchez E, Canfield MA, Dastgiri S, Feldkamp ML, Gatt M, Groisman B, Hurtado-Villa P, Kallen K, Landau D, Lelong N, Lopez-Camelo J, Martinez LE, Mastroiacovo P, Morgan M, Mutchinick OM, Nance AE, Nembhard WN, Pierini A, Sipek A, Stallings EB, Szabova E, Tagliabue G, Wertelecki W, Zarante I, Rissmann A. Prevalence and mortality among children with anorectal malformation: A multi-country analysis. *Birth defects research*. 2023; 115(3): 390-404.
- Gili JA, López-Camelo JS, Nembhard WN, Bakker M, de Walle HE, Stallings EB, Kancherla V, Group EP, Contiero P, Dastgiri S, Feldkamp ML, Nance A, Gatt M, Martínez L, Canessa MA, Groisman B, Hurtado-Villa P, Källén K, Landau D, Lelong N, Morgan M, Arteaga-Vázquez J, Pierini A, Rissmann A, Sipek A, Szabova E, Wertelecki W, Zarante I, Canfield MA, Mastroiacovo P. Analysis of early neonatal case fatality rate among newborns with congenital hydrocephalus, a 2000–2014 multi-country registry-based study. *Birth defects research*. 2022; 114(12): 631-644.
- Bell JC, Baynam G, Bergman JE, Bermejo-Sánchez E, Botto LD, Canfield MA, Dastgiri S, Gatt M, Groisman B, Hurtado-Villa P, Kallen K, Khoshnood B, Konrad V, Landau D, Lopez-Camelo JS, Martinez L, Morgan M, Mutchinick OM, Nance AE, Nembhard W, Pierini A, Rissmann A, Shan X, Sipek A, Szabova E, Tagliabue G, Yevtushok LS, Zarante I, Nassar N. Survival of infants born with esophageal atresia among 24 international birth defects surveillance programs. *Birth defects research*. 2021; 113(12): 945-957.
- Politis MD, Bermejo-Sánchez E, Canfield MA, Contiero P, Cragan JD, Dastgiri S, de Walle HE, Feldkamp ML, Nance A, Groisman B, Gatt M, Benavides-Lara A, Hurtado-Villa P, Kallén K, Landau D, Lelong N, Lopez-Camelo J, Martinez L, Morgan M, Mutchinick OM, Pierini A, Rissmann A, Šípek A, Szabova E, Wertelecki W, Zarante I, Bakker MK, Kancherla V, Mastroiacovo P, Nembhard WN. Prevalence and mortality in children with congenital diaphragmatic hernia: a multicountry study. *Annals of epidemiology*. 2021; 56: 61-69. e63.
- Nembhard WN, Bergman JE, Politis MD, Arteaga-Vázquez J, Bermejo-Sánchez E, Canfield MA, Cragan JD, Dastgiri S, de Walle HE, Feldkamp ML, Nance A, Gatt M, Groisman B, Hurtado-Villa P, Kallén K, Landau D, Lelong N, Lopez-Camelo J, Martinez L, Morgan M, Pierini A, Rissmann A, Šípek A, Szabova E, Tagliabue G, Wertelecki W, Zarante I, Bakker MK, Kancherla V, Mastroiacovo P. A multi-country study of prevalence and early childhood mortality among children with omphalocele. *Birth defects research*. 2020; 112(20): 1787-1801.
- Bakker MK, Kancherla V, Canfield MA, Bermejo-Sanchez E, Cragan JD, Dastgiri S, De Walle HE, Feldkamp ML, Groisman B, Gatt M, Hurtado-Villa P, Kallen K, Landau D, Lelong N,

- Lopez Camelo JS, Martínez L, Morgan M, Mutchinick OM, Nembhard WN, Pierini A, Rissmann A, Sipek A, Szabova E, Tagliabue G, Wertelecki W, Zarante I, Mastroiacovo P. Analysis of mortality among neonates and children with spina bifida: an international registry-based study, 2001-2012. *Paediatric and perinatal epidemiology*. 2019; 33(6): 436-448.
18. Goel N, Morris JK, Tucker D, de Walle HE, Bakker MK, Kancherla V, Marengo L, Canfield MA, Kallen K, Lelong N, Camelo JL, Stallings EB, Jones AM, Nance A, Huynh MP, Martínez-Fernández ML, Sipek A, Pierini A, Nembhard WN, Goetz D, Rissmann A, Groisman B, Luna-Muñoz L, Szabova E, Lapchenko S, Zarante I, Hurtado-Villa P, Martinez LE, Tagliabue G, Landau D, Gatt M, Dastgiri S, Morgan M. Trisomy 13 and 18-Prevalence and mortality-A multi-registry population based analysis. *American journal of medical genetics Part A*. 2019; 179(12): 2382-2392.
 19. Yu X, Nassar N, Mastroiacovo P, Canfield M, Groisman B, Bermejo-Sánchez E, Ritvanen A, Kiuru-Kuhlefelt S, Benavides A, Sipek A, Pierini A, Bianchi F, Källén K, Gatt M, Morgan M, Tucker D, Canessa MA, Gajardo R, Mutchinick OM, Szabova E, Csáky-Szunyogh M, Tagliabue G, Cragan JD, Nembhard WN, Rissmann A, Goetz D, Bower C, Baynam G, Lowry RB, Leon JA, Luo W, Rouleau J, Zarante I, Fernandez N, Amar E, Dastgiri S, Contiero P, Martínez-de-Villarreal LE, Borman B, Bergman JEH, de Walle HEK, Hobbs CA, Nance AE, Agopian AJ. Hypospadias prevalence and trends in international birth defect surveillance systems, 1980-2010. *European urology*. 2019; 76(4): 482-490.
 20. Mc Goldrick N, Revie G, Groisman B, Hurtado-Villa P, Sipek A, Khoshnood B, Rissmann A, Dastgiri S, Landau D, Tagliabue G, Pierini A, Gatt M, Mutchinick OM, Martínez L, de Walle HEK, Szabova E, Lopez Camelo J; ECEMC Peripheral Group; Källén K, Morgan M, Wertelecki W, Nance A, Stallings EB, Nembhard WN, Mossey P. A multi-program analysis of cleft lip with cleft palate prevalence and mortality using data from 22 International Clearinghouse for Birth Defects Surveillance and Research programs, 1974-2014. *Birth defects research*. 2023; 115(10): 980-997.
 21. Al-Dewik N, Samara M, Younes S, Al-Jurf R, Nasrallah G, Al-Obaidly S, Salama H, Olukade T, Hammuda S, Marlow N. Prevalence, predictors, and outcomes of major congenital anomalies: A population-based register study. *Scientific Reports*. 2023; 13(1): 2198.
 22. Asemi-Rad A, Heidari Z, Mahmoudzadeh-Sagheb H, Mehdipour Y, Moudi B, Sheibak N, Ebrahimi S. Prevalence of congenital anomalies and related factors in live births in Zahedan, Southeast of Iran: A cross-sectional study. *International Journal of Reproductive BioMedicine*. 2023; 21(21): 647-656.