ORIGINAL RESEARCH

Epidemiological Study of Congenital Anomalies and Risk Factors in Newborn Infants at a Tertiary Care Hospital in Bangladesh

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Abstract

Background: Congenital anomalies are structural/functional defects in various organs (systems) that are apparent at birth. These anomalies originate prior to birth due to altered embryonic/fetal development. These are significant contributors to stillbirths/infant mortality over the world; the global variation in incidence is possibly related to regional differences in exposure to various etiological factors.

Objectives: To investigate the epidemiological profile of various congenital abnormalities in newborn infants in Bangladesh.

Materials and methods: This cross-sectional observational study was conducted in Central Medical College Hospital, Cumilla, Bangladesh. We recorded 100 consecutive congenital anomalies in 54,800 infant visits in our outpatient clinics. Data were collected from families after informed written consent.

Results: Out of the 100 infants with congenital anomalies, 69 infants were male and 31 were female (gender ratio 2.2:1). Congenital abnormalities were seen in the central nervous system (CNS) in 30, in the musculoskeletal system in 24, gastrointestinal in 24, cardiovascular in 13, and the genitourinary system in 9 infants. Thirty-eight infants had a history of antenatal exposure to radiation, and 35 of them to pesticides. Twenty-two were born to mothers with diabetes, and 18 to mothers with hypertension.

Conclusion: We identified antenatal exposure to radiation, pesticides, maternal diabetes, and maternal hypertension as important predisposing factors for congenital anomalies. Congenital anomalies of the CNS and musculoskeletal/gastrointestinal defects were seen most frequently. Identification of risk factors can help in designing appropriate interventions.

Keywords: Ambiguous genitalia, Anencephaly, Atrial septal defect, Bangladesh, Birth-defect registries, Chromosomal abnormalities, Cleft palate, Cleft lip, talipes, Congenital anomalies, Congenital diaphragmatic hernia, Cytomegalovirus, Duodenal atresia, Embryonic development, Environmental contaminants, Epidemiological profile, Epidemiology, External teratogens, Fetal development, Folic acid deficiency, Global Burden of Disease study, Hydrocephalus, Hypospadias, ICD-9, ICD-10, Infant, Inguinal hernia, Iodine deficiency, Imperforate anus, Meningomyelocele, Micronutrients, Multifactorial transmission, Newborn, Patent ductus arteriosus, Pesticides, Polydactyly, Radiation, Rubella, Single-gene disorders, Spina bifida, Syndactyly, Tetralogy of Fallot, Tracheoesophageal fistula, Undescended testis, Ventricular septal defect.

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Highlights

- Congenital anomalies are structural/functional defects in various organs (systems) that are apparent at birth.
- In this study, we investigated the epidemiological profile of various congenital abnormalities in newborn infants in Bangladesh.
- We recorded 100 consecutive congenital anomalies in 54,800 infant visits in our outpatient clinics.
- Congenital anomalies of the central nervous system (CNS) and musculoskeletal/gastrointestinal defects were seen most frequently.
- Antenatal exposure to radiation, pesticides, maternal diabetes, and maternal hypertension as important predisposing factors for congenital anomalies. Identification of risk factors can help in designing appropriate interventions.

Introduction

Congenital birth defects include structural/functional abnormalities present since birth. An estimated 7.9 million infants are born all

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over the world with these conditions and are at risk of physical impairment after birth and perinatal mortality.[1,2] More than 90% of these defects are seen in low-resource regions that have very few birth-defect registries with detailed information.[3] Due to low awareness, inadequate diagnostic capabilities, under-presentation to medical institutions, and consequent under-reporting, the prevalence of congenital anomalies is considerably underestimated in these areas.[4]

We know that congenital malformations are caused by a variety of factors, including single-gene disorders, chromosomal abnormalities, multifactorial transmission, external teratogens, and micronutrient shortages.[5] Maternal infections such as rubella and cytomegalovirus; diabetes mellitus; iodine and folic acid deficiencies; exposure to medicinal and recreational drugs such as alcohol and tobacco; certain environmental contaminants; and radiation are important than other important predisposing factors.[6] In the 2015 Global Burden of Disease study, congenital abnormalities accounted for 11% of infant deaths. These were the sixth most common cause of mortality in under-5-years-old children.[7] These issues can also cause long-term impairment, affecting society, families, healthcare systems, and individuals.[8] Overall, 1 in 40 (2.5%) infants are born with one or more detectable deformities; nearly half of these cases were born with 1 deformity, whereas the other half had more than one.[9]

Regular prenatal assessment and directed care can reduce perinatal mortality.[10] Malformations are broadly classified into the following three types: (A) Single deformity; (B) multiple deformities with a recognizable pattern (syndrome); and (C) multiple malformations without an identifiable pattern. Minor malformations are structural defects that may not alter clinical function but may have esthetic implications, such as preauricular tags. Major malformations, such as cleft lip and palate, or ventricular septal defects, have a substantial impact on function or social acceptability.[11]

Congenital birth defects can often present as syndromes, where several pathophysiologically connected abnormalities originate in a shared cause.[11] Organ development is crucial throughout the first trimester, especially between the 3–8-week period of pregnancy. During this time, any type of injury might induce multiple congenital abnormalities.[12] In many regions, perinatal infections, or macro- and micronutrient malnutrition might increase the risk of birth malformations; up to 94% of all birth defects may be seen in such settings[5,13] In some regions, dietary supplementation with folic acid has reduced the prevalence of neural tube abnormalities. Genetic factors may also be at play; the incidence of congenital deformities may be higher in low-birth-weight (LBW) infants and in those born from consanguineous marriages.[14] The risk of congenital malformations increases with advanced maternal age, exposure to certain drugs, teratogens, radiation, maternal illnesses, smoking, and alcohol consumption.[15] The incidence and type of congenital abnormalities in various geographic regions may also change with ethnicity, socioeconomic level, diet, environmental variables, maternal age, and lifestyle.[16]

There is a need for further work to identify the cause and possible interventions to prevent congenital anomalies. An improved understanding of the epidemiology of birth abnormalities can help design directed efforts to prevent these defects. In this study, we took the first steps to screen for the prevalence of different congenital anomalies in infants in our community.

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Materials and Methods

Study Design and Setting

This cross-sectional observational study was performed at the outpatient clinics in the Central Medical College Hospital in Cumilla, Bangladesh during the period from June 2019 to June 2022. The approval of the ethics review committee was obtained prior to the initiation of the study. Parents' consent was obtained prior to enrollment for data collection, and strict confidentiality was maintained while processing the data and creating the reports by eliminating all personal identifiers. Data were collected from the first 100 patients with congenital anomalies who presented to the outpatient clinics during the period from June 2019 to June 2022. The total number of patients seen during the study period was 54,800. Various anomalies were recorded based on physical examinations of the infants. Information such as maternal parity, gestational age, education, social standing, family history of congenital malformations, illness in a sibling, cousin marriages, relationships with cousins, concomitant medical conditions, industrial exposure, and viral infections in the first trimester were also noted. The frequency and pattern of anomalies, male-to-female ratio, and the severity of congenital malformations were noted as outcome variables.

Statistical Analysis

Microsoft Excel and statistical package for the social sciences (SPSS) software, version 25.0, were used for data entry and analysis. Sociodemographic information, risk variables, and congenital malformations were all summarized using descriptive statistics. Qualitative data are reported as frequency and percentage, whereas quantitative data are given as mean and standard deviation. Comparisons were made using tabulation and graphic displays such as tables and bar diagrams.

Results and Observation

Out of the 54,800 patients seen during the study period, 100 patients were identified with congenital anomalies. The recorded anomalies encompassed a range of conditions, including cardiovascular, musculoskeletal, and neurological anomalies, among others. The calculated percentage of patients with congenital anomalies was approximately 0.1825%.

Table 1 shows demographic characteristics. Gender distribution of the neonates revealed that out of 100 cases, 69.0% of patients were male and 31.0% were female. Male–female ratio was 2.2:1. A total of 57% of the respondents came from urban areas. Notably, 67% of them had a history of hospital delivery.

Evaluation of maternal risk factors showed that 38.0% of the patient had been exposed to antenatal radiation, 35% had exposure

to pesticides, 22% were diagnosed to have had diabetes, and 18% had hypertensive disorders (Table 2).

Table 3 shows the prevalence of different types of congenital malformations. Cleft lip/palate was detected in 13 patients; talipes in 12, polydactyly in 9, hypospadias in 8, and meningomyelocele in five patients. Other common malformations were atrial septal defect, inguinal hernia, ventricular septal defect, imperforate anus, duodenal atresia, tracheoesophageal fistula, anencephaly, syndactyly, etc.

The pattern of congenital abnormalities present in neonates is summarized in Figure 1. Anomalies were noted most frequently in the CNS (30%), followed by the musculoskeletal system (24%), gastrointestinal system (24%), cardiovascular system (CVS) (13%), and the genitourinary system (9%).

Table 4 shows the relationship between congenital abnormalities and maternal and fetal factors. It was evident that male subjects are commonly affected by CNS and gastrointestinal anomalies, females are commonly affected by musculoskeletal system deformities. Maternal parity is an important predictor of congenital anomalies. Infants born to primigravidae women showed more anomalies in the central nervous and genitourinary systems. The CVS malformations were more common in multiparous women. Births in urban areas showed more CVS and genitourinary system anomalies, whereas gastrointestinal system

Table 1: Demographic characteristics of the newborn ($n = 100$)

	Frequency		
Variables	*Male (n, %)*	*Female (n, %)*	*Total*
Gender distribution	69	31	100
Residence			
Rural	29 (42.0%)	14 (45.1%)	43
Urban	40 (57.9%)	17 (54.8%)	57
Place of delivery			
Home	21 (30.4%)	10 (32.2%)	31
Hospital	48 (69.5%)	21 (67.7%)	69
Mode of delivery			
NVD	43 (62.3%)	19 (61.2%)	62
CS	26 (37.6%)	12 (38.7%)	38

CS, cesarean section; NVD, normal vaginal delivery

Table 2: Maternal risk factors ($n = 100$)

Variables	*Number of patients*
Exposed to antenatal radiation	38
Exposure to pesticides	35
Maternal diabetes	22
Maternal hypertensive disorder	18
Prior history of antiseizure medication	7
Poor nutritional status	27

Table 3: Different types of congenital malformations observed in neonates ($n = 100$)

Clinical diagnosis	*Number of patients*
Cleft palate and cleft lip	13
Talipes	12
Ventricular septal defect	5
Patent ductus arteriosus	4
Tetralogy of Fallot	3
Congenital diaphragmatic hernia	2
Anencephaly	3
Tracheoesophageal fistula	4
Polydactyly	9
Meningomyelocele	5
Hydrocephalus	5
Hypospadias	8
Inguinal hernia	5
Imperforate anus	5
Syndactyly	3
Duodenal atresia	4
Undescended testis	2
Atrial septal defect	5
Spina bifida	2
Ambiguous genitalia	1

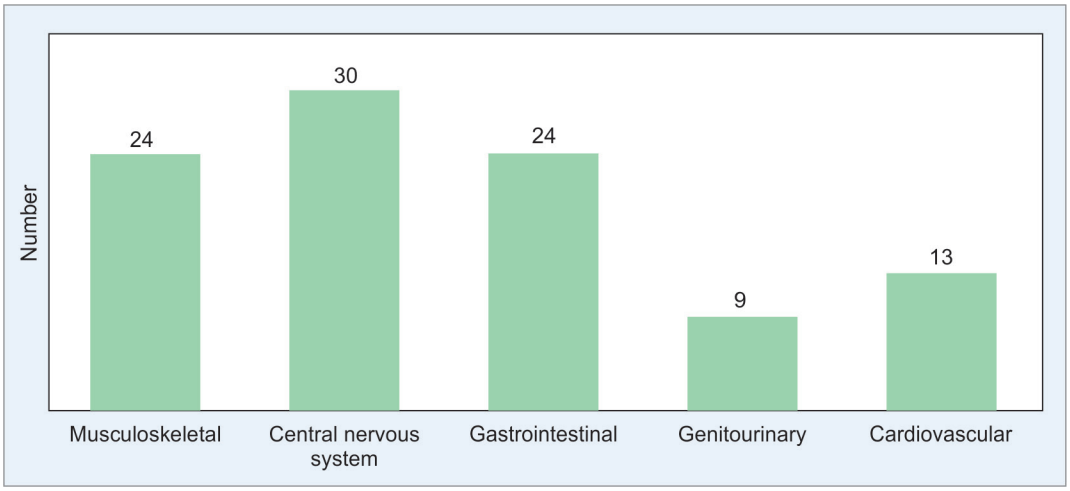

Fig. 1: Distribution of the pattern of congenital anomalies ($n = 100$)

Table 4: Congenital malformations in relation to maternal and fetal factors ($n = 100$)

	CNS	*Musculoskeletal system*	*Gastrointestinal system*	*CVS*	*Genitourinary system*	*Total*
Newborn gender						
Male	21	11	19	9	9	69
Female	9	13	5	4	0	31
Maternal history						
Primigravida	26	13	14	6	6	65
Multigravida	4	11	10	7	3	35
Residence						
Urban	17	14	11	8	7	57
Rural	13	10	13	5	2	43
Exposed to antenatal radiation						
Yes	17	15	5	0	1	38
No	13	9	19	13	8	62
Exposure to pesticides						
Yes	14	11	3	5	2	35
No	16	13	21	8	7	65

anomalies were seen more frequently in rural regions. Maternal exposure to radiation and pesticides were important risk factors for congenital malformations.

Discussion

Out of 100 cases in this study, 69% were male and 31% were female (gender ratio was 2.2:1). A total of 57% of responders were from urban areas; 69% of our patients had a history of hospital delivery. Most (62%) had been delivered vaginally. Our study differed from other cohorts, where the gender ratios were relatively similar. In a screening study of 50 patients, 54% were males with a gender ratio of 1.2:1.[5] In a larger cohort of 3,210 admissions, 226 newborns (7%) had congenital malformations.[11] In this study, 130 (57.5%) were male patients and 96 (42.5%) were female patients. Another study with congenital anomalies in 8.4% showed 52 (54.1%) males and 44 (45.8%) females.[13] These studies show a wide variation in geographic distribution, cultural influences, and socioeconomic conditions.

We recorded a high frequency of cleft lip and palate, talipes, polydactyly, hypospadias, and meningomyelocele. Other common malformations were an atrial septal defect, inguinal hernia, ventricular septal defect, imperforate anus, duodenal atresia, tracheoesophageal fistula, anencephaly, and syndactyly. Overall, the CNS (30%) was the most often afflicted system in this study, followed by the musculoskeletal system (24%), gastrointestinal system (24%), CVS (13%), and genitourinary system (9%) of total abnormalities. However, a review of the literature shows considerable variability between cohorts. One study showed a high frequency of neurological anomalies (2.3%); anencephaly (11.5%), spina bifida (11.5%), and meningocele (12.3%). Clubfoot (7.7%), omphalocele (3.8%), and gastroschisis (3.8%) were the most prevalent musculoskeletal abnormalities (3.1%). The most prevalent gastrointestinal tract abnormalities were esophageal atresia (4.6%), Pierre–Robin syndrome (4.6%), cleft lip (18.5%), and cleft palate (16.2%).[1] In another cohort, the circulatory system was most frequently implicated, followed by the neurological and musculoskeletal systems.[16] Another study showed a relatively large number of neural tube defects but also two with Down's syndrome, one with a facial abnormality, and three with congenital cardiac disease.[17]

Many risk factors were associated with congenital anomalies. In our cohort, parental consanguinity, maternal undernutrition, obesity, a history of abnormalities in the family, LBW, and preterm birth were associated with a higher prevalence of congenital malformation with non-significant differences for maternal age and neonate sex.[5] Evaluation of maternal history and risk factors, 38% of the mothers had been exposed to antenatal radiation and 35% to pesticides. Male infants were more frequently affected by CNS and gastrointestinal anomalies, unlike females who had a higher incidence of musculoskeletal system deformities. Interestingly, maternal parity was also an important predictor of specific congenital anomalies. Primigravidae women more frequently carried fetuses with CNS and genitourinary system anomalies. Multiparous mothers frequently gave birth to fetuses with CVS malformations. On the evaluation of residence, infants born in urban areas frequently showed cardiovascular and genitourinary system anomalies, unlike the higher numbers of gastrointestinal defects seen in rural areas.

One study focused on maternal and infant risk factors for congenital malformations. Although not statistically significant, low or high maternal ages (<20 or >35 years) were associated with a higher risk of congenital deformities.[18] Parental consanguinity was an important risk factor. Maternal malnutrition and obesity were both related to an increase in congenital malformations in their fetuses. Fetal gender was not an important determinant. Prematurity and LBW increased the risk of congenital abnormalities.[5] Birth weight, maternal diseases, inadequate prenatal care, smoking, prior abortion, past congenital abnormalities, and consanguinity have been associated with congenital malformations.[19] Circulatory problems appear to be more prevalent when compared to previous research, which is important to know because many of these infants can be salvaged with timely intervention.[20] Public education about various risk factors, maternal health, and the need for early prenatal identification and therapy can help.[21] Timely intervention in known risk factors such as folic acid or iodine deficiency may

help, although more work is needed to confirm the size of the therapeutic impact.[22,23] There is a need for standardized systems for categorizing birth defects (such as the International Classification of Diseases [ICD]-9 or ICD-10) so that data can be compared across various geographical regions and over time.[24] The Global Burden of Disease Study and WHO reviews show that up to 17–42% of infant mortality may be related to congenital anomalies.[25] There is considerable variability in the incidence of various congenital abnormalities in different regions, so the efforts need to be directed more precisely.

Conclusion

The CNS and musculoskeletal issues are the most common congenital defects. Congenital anomalies were more common when the mother had a history of exposure to radiation, chemicals, paternal consanguinity, and diseases. Long-term disabilities resulting from congenital defects may have a considerable effect on a child's health and development as well as on families, healthcare systems, and on society as a whole. Proper evaluation and appropriate treatment prevent the burden of congenital anomalies.

Authors' Contributions

Md. Zahirul Alam designed the study and supervised the project; Minhazur Rahman Tareq and Dildar Sultana Shapna participated in patients' enrollment. Akhil Maheshwari helped in preparing the draft and confirmed the manuscript's accuracy; Mainul Hasan Sohel and Kawser Hamid performed data analysis; Md. Mahabubul Islam Majumder contributed significantly and took part in the enrolling of patients. The final version of the work has been reviewed and approved by all authors.

Data Availability Statement

Data will be made available on request.

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Ethical Approval

The Central Medical College's ethics review committee granted its approval. Patients were informed of the experiment and given their consent prior to the data collection. The strictest confidentiality was upheld while processing the data and creating the report by eliminating names and other personal identifiers.

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