Original Article

Independent factors associated with birth defects during the whole of pregnancy in Shenyang City, China: a case-control study

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Background: Birth defects, as a kind of diseases that seriously affect human life, have always attracted much attention. In the past, perinatal data have been studied for birth defects. This study analyzed the surveillance data of birth defects during the perinatal period and the whole of pregnancy, as well as the independent influencing factors, to help to minimize their risk of birth defects.

Methods: A total of 23,649 fetuses delivered in the hospital from January 2017 to December 2020, were enrolled in this study. There were 485 cases of birth defects, including live births and stillbirths by detailed inclusion and exclusion criteria. Maternal and neonatal clinical data were collated to analyze the influencing factors associated with birth defects. Pregnancy complications and comorbidities were diagnosed according to the criteria of the Chinese Medical Association. Univariate and multivariate logistic regression models were used to investigate the association between independent variables and birth defect events.

Results: The incidence of birth defects during the whole of pregnancy was 175.46/10,000, while the incidence of perinatal birth defects was 96.22/10,000. The birth defect group had significantly higher maternal age, gravidity, parity, rate of preterm birth, cesarean section (CS) rate, scarred uterus, stillborn, and male newborns compared to the control group. Multivariate logistic regression model analysis showed that preterm birth [odds ratio (OR): 1.69, 95% confidence interval (CI): 1.01 to 2.86], CS (OR: 1.46, 95% CI: 1.08 to 1.98), scarred uterus (OR: 1.70, 95% CI: 1.01 to 2.85), and low birth weight (OR >4 compared to the other two classes) were significantly associated with birth defects during the whole of pregnancy (all $P<0.05$). The independent influencing factors associated with perinatal birth defects included CS (OR: 1.43, 95% CI: 1.05 to 1.93), gestational hypertension (OR: 1.70, 95%: 1.04 to 2.78), and low birth weight (OR >3.70 compared to the other two classes).

Conclusions: The discovery and monitoring of known influencing factors associated with birth defects, such as, preterm birth, gestational hypertension, low birth weight, should be enhanced. For the controllable influencing factors, obstetrics providers should work with patients to minimize their risk of birth defects.

Keywords: Birth defects; whole pregnancy; perinatal period; epidemiology; influencing factors

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Introduction

Birth defects are defined as structural or functional abnormalities occurring during the development of the fetus in utero, which can be diagnosed before or at birth (1). Birth defects are 1 of the 25 major causes impacting disability-adjusted life years (DALYs) worldwide (2). In addition, many structural birth defects are related to advanced cancers in the same organ system or anatomical site (3). According to the World Health Organization (WHO), the incidences of birth defects in the low-, middle-, and high-income countries are 6.42%, 5.57%, and 4.72%, respectively (4). In China, birth defects affect approximately 900,000 (5.6%) fetuses each year, and is a major cause of infant mortality and morbidity (5).

Etiologies of birth defects include multiple factors, such as single-gene defects, chromosomal disorders, multi-factor inheritance, environmental teratogens, and micronutrient deficiencies (6). In recent years, a variety of risk factors for birth defects have been found, such as, advanced maternal age, environmental risk factors (maternal exposure to air pollution and toxic chemicals, parental smoking), polymorphisms in genes of folate metabolism and so on (7-9). However, there are few studies on the correlation between preterm birth, birth weight and birth defects.

Highlight box

Key findings

- Preterm birth, cesarean section (CS), scarred uterus, and low birth weight were associated with birth defects during the whole of pregnancy. The independent influencing factors associated with perinatal birth defects included CS, gestational hypertension, and low birth weight.

What is known and what is new?

- The etiology of birth defects includes multiple factors, such as single-gene defects, chromosomal disorders, multi-factor inheritance, environmental teratogens, and micronutrient deficiencies. In China, birth defects affect approximately 900,000 (5.6%) fetuses each year, and is a major cause of infant mortality and morbidity.
- The incidence of birth defects during the whole of pregnancy was much higher than the incidence of perinatal birth defects. The birth defects data from perinatal surveillance data will underestimate the overall prevalence of some birth defects.

What is the implication, and what should change now?

- We should increase the surveillance of birth defects and pay attention to the relationship between CS, gestational hypertension, low birth weight and birth defects.

Surveillance allows for the planning, implementation, and evaluation of health strategies, and the integration of data into the decision-making process to help prevent adverse health conditions. Considering the development of social economic status and maternal and child health in China, the Chinese Ministry of Health launched the hospital-based birth defects surveillance systems in 1986 (10), from 28 weeks of gestation to 7 days after birth, focusing on 23 types of common structural abnormalities, chromosomal abnormalities, and a small number of genetic metabolic diseases in perinatal infants. In recent years, the prevalence of termination of pregnancy due to fetal anomaly (TOPFA) before 28 weeks of gestation has increased due to the popularity of prenatal screening and improved diagnostic accuracy (11), especially for severe abnormalities. As a result, the usual birth defects data from perinatal surveillance data will underestimate the overall prevalence of some birth defects. It is particularly important to increase birth defects data during the whole of pregnancy.

To provide a reference for the prevention and surveillance of birth defects, we herein conducted an epidemiological analysis of birth defects during the perinatal period and the whole term of pregnancy. We added preterm birth, delivery method, scarred uterus and diagnosis of newborn body weight herein. Meanwhile, independent influencing factors associated with birth defects were also investigated. We present the following article in accordance with the STROBE reporting checklist (available at https://tp.amegroups.com/article/view/10.21037/tp-23-197/rc).

Methods

Study subjects

A total of 23,649 fetuses delivered in the General Hospital of Northern Theater Command from January 2017 to December 2020, were included for analysis (from 12 weeks of gestation to 7 days after birth). There were 485 cases of birth defects, including live births and stillbirths, and these were classified as the birth defect group. There remaining fetuses were considered the control group. The inclusion criteria for the birth defect group were as follows: (I) the fetus underwent therapeutic induction of labor due to a diagnosed birth defect; and (II) the neonate was diagnosed with birth defects within 7 days of birth. The exclusion criteria for the birth defect group included the following: (I) fetuses that underwent therapeutic induction of labor due to other reasons not related to birth defects; (II) multiple births; and (III) fetuses that were stillborn *in utero* with no relevant examination data before admission. This study was approved by the Institutional Review Board (IRB) of General Hospital of Northern Theater Command of the Chinese People's Liberation Army [No. Y(2020)025]. Written informed consent was waived by the IRB due to the retrospective nature of this study. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

Diagnosis of birth defects

According to the "Chinese Maternal and Child Health Monitoring Manual" formulated by the National Office for Maternal and Child Health Surveillance of China (12), the 23 types of major birth defects were diagnosed by uniformly trained doctors based on clinical manifestations, physical examinations, and various auxiliary examination results. The diagnostic criteria for other defects were derived from the China Birth Defects Monitoring System and Minimal Malformation Reporting Guidelines.

Data collection

Live births among the included cases were clinically confirmed. Cases confirmed by prenatal diagnosis were performed in prenatal diagnosis centers or hospitals qualified for prenatal diagnosis. Physicians responsible for diagnosing birth defects and data collectors were professional and trained obstetric or pediatric health practitioners. Data from electronic medical records and perinatal birth defect registration cards were collated, from January 2017 to December 2020, including maternal characteristics (such as age, gravidity, parity, number of births in this pregnancy, pregnancy complications, and pregnancy comorbidities) and neonatal characteristics (such as gender, birth weight, gestational age, and mode of delivery).

Hypertensive diseases in pregnancy complications and comorbidities included gestational hypertension, preeclampsia, eclampsia, chronic hypertension complicated by preeclampsia, and chronic gestational hypertension. Diabetes included gestational diabetes mellitus (GDM) and pre-gestational diabetes mellitus (PGDM), with the latter including type 1 and type 2 diabetes mellitus. Hypothyroidism included gestational hypothyroidism and hypothyroidism combined with pregnancy. Anemia includes gestational anemia and anemia combined with pregnancy.

The incidence of birth defects was defined as the number of cases of birth defects per 10,000 births in a defined area within a certain period (5). Since fetal sex data were partially missing, this factor was not included in the analysis of independent variables affecting birth defects.

Statistical analysis

Continuous data were presented as mean ± standard deviation (SD). For the comparisons between the two groups, the student's independent *t*-test or Mann-Whitney U test (if normality was not assumed) were used. Categorical data was presented as number and percentage (%), and the distribution was tested using the Chi-square test or Fisher's exact test (if any expected value ≤5 was observed). Univariate and multivariate logistic regression models were used to investigate the association between independent variables and birth defect events.

The variables which differed between groups in *Table 1* were used in the investigation. The incidence rates of different subtypes of birth defects stratified by different delivery outcomes are analyzed in *Table 2*. All independent variables associated with birth defects during the perinatal period and the whole of pregnancy were investigated. Then the variables which were significant in univariate results were entered into a multivariate model. The variables which were significant in the multivariate model were recognized as an associated factor with the outcome event. A P value <0.05 was considered statistically significant in each test, two-tailed. All analyses were performed using IBM SPSS Version 25 software (SPSS Statistics V25, IBM Corporation, Somers, New York).

Results

Demographic and clinical characteristics

From 2017 to 2020, a total of 23,649 fetuses were included in this study. There were 485 cases of birth defects (designated as the birth defect group) and 23,164 healthy fetuses (designated as the control group). Demographic and clinical characteristics of all cases are summarized in *Table 1*. The mean maternal age was 29.77±3.80 years, and the mean gravidity and parity were 1.69±0.98 and 0.22±0.42, respectively. There were 739 cases (3.16%) of preterm births. As for the delivery method, 62.33% of cases were normal spontaneous delivery (NSD) and 37.67% of cases were cesarean section (CS). Regarding maternal disease

Table 1 Demographic and clinical characteristics of the included cases

Variables	Control (n=23,164)	Birth defects (n=485)	All	P
Maternal age (years)	29.75±3.78	30.73±4.39	29.77±3.80	<0.001
Gravidity	1.69±0.98	1.89±1.06	1.69±0.98	<0.001
Parity	0.22±0.42	0.30±0.48	0.22±0.42	<0.001
Preterm birth		(Live births, n=210)		<0.001
Yes	710 (3.07)	29 (13.81)	739 (3.16)	
No	22,454 (96.93)	181 (86.19)	22,635 (96.84)	
Delivery method		(Live births)		<0.001
NSD	14,496 (62.58)	72 (34.29)	14,568 (62.33)	
CS	8,668 (37.42)	138 (65.71)	8,806 (37.67)	
Diabetes				0.109
No	12,280 (88.13)	439 (90.52)	12,719 (88.21)	
Yes	1,654 (11.87)	46 (9.48)	1,700 (11.79)	
Hypertension				0.320
No	13,371 (95.96)	461 (95.05)	13,832 (95.93)	
Yes	563 (4.04)	24 (4.95)	587 (4.07)	
Scarred uterus				<0.001
No	12,627 (90.62)	412 (84.95)	13,039 (90.43)	
Yes	1,307 (9.38)	73 (15.05)	1,380 (9.57)	
Newborn body weight		(Live births)		<0.001
Low birth weight	347 (1.50)	25 (11.90)	372 (1.59)	
Normal weight	21,578 (93.15)	173 (82.38)	21,751 (93.06)	
Macrosomia	1,239 (5.35)	12 (5.71)	1,251 (5.35)	
Sex of newborn	(Recorded part)	(Live births)		<0.001
Male	343 (50.37)	135 (64.29)	478 (53.65)	
Female	338 (49.63)	75 (35.71)	413 (46.35)	
Anemia				0.911
No	21,365 (92.23)	448 (92.37)	21,813 (92.24)	
Yes	1,799 (7.77)	37 (7.63)	1,836 (7.76)	
Hypothyroidism				0.324
No	22,354 (96.50)	464 (95.67)	22,818 (96.49)	
Yes	810 (3.50)	21 (4.33)	831 (3.51)	
Year				0.361
2017	6,421 (27.72)	117 (24.12)	6,538 (27.65)	
2018	5,886 (25.41)	132 (27.22)	6,018 (25.45)	
2019	6,596 (28.48)	145 (29.90)	6,741 (28.50)	
2020	4,261 (18.39)	91 (18.76)	4,352 (18.40)	

Data are shown as mean ± standard deviation or n (%). NSD, normal spontaneous delivery; CS, cesarean section.

Table 2 Subgroup analysis of defect types stratified by different delivery outcomes

Parameter	Delivery outcomes, n (%)			P
	Dead (n=275)	Live (n=210)	All (n=485)	
Defect type				<0.001
Other defects	109 (39.64)	30 (14.29)	139 (28.66)	
Congenital heart disease	67 (24.36)	3 (1.43)	70 (14.43)	
Deformity of the outer ear	0	69 (32.86)	69 (14.23)	
Polydactyly	1 (0.36)	36 (17.14)	37 (7.63)	
Down's syndrome	31 (11.27)	0	31 (6.39)	
Syndactyly	2 (0.73)	20 (9.52)	22 (4.54)	
Cleft lip	21 (7.64)	2 (0.95)	23 (4.74)	
Cleft palate	0	13 (6.19)	13 (2.68)	
Cleft lip and palate	12 (4.36)	1 (0.48)	13 (2.68)	
Hypospadias	0	11 (5.24)	11 (2.27)	
Imperforate anus or stenosis	0	9 (4.29)	9 (1.86)	
Congenital clubfoot	3 (1.09)	5 (2.38)	8 (1.65)	
Hydrocephalus	7 (2.55)	0	7 (1.44)	
Short limbs deformity	3 (1.09)	3 (1.43)	6 (1.24)	
Spinal dysraphism	4 (1.45)	1 (0.48)	5 (1.03)	
Microtia and anotia	0	6 (2.86)	6 (1.24)	
Encephalocele	3 (1.09)	0	3 (0.62)	
Omphalocele	2 (0.73)	1 (0.48)	3 (0.62)	
Gastroschisis	5 (1.82)	0	5 (1.03)	
Anencephaly	2 (0.73)	0	2 (0.41)	
Esophageal atresia or stenosis	1 (0.36)	0	1 (0.21)	
Diaphragmatic hernia	1 (0.36)	0	1 (0.21)	
Conjoined twins	1 (0.36)	0	1 (0.21)	

history, there were 11.79% of cases with diabetes, 4.07% with hypertension, and 9.57% with a scarred uterus.

Examination of the fetal characteristics revealed that 1.59% and 5.35% of cases had low birth weight and macrosomia, respectively. There were 275 cases (1.16%) of stillborn. Only a few cases in the control group were recorded with sex, however, the overall percentages of male and female fetuses were 53.65% and 46.35%, respectively. Of the whole population, 7.76% were anemic and 3.51% had hypothyroidism.

A comparison between the two groups showed that the birth defect group had significantly higher maternal age, gravidity, parity, rate of preterm birth, CS rate, scarred uterus, stillborn, and male newborns compared to the control group (all P<0.001).

Subgroup analysis of defect type

Table 2 and *Figure 1* detail all 22 defect types between stillborn and live birth cases in the birth defect group. The distribution of defect types was significantly different between the stillborn and live birth subgroups (P<0.001).

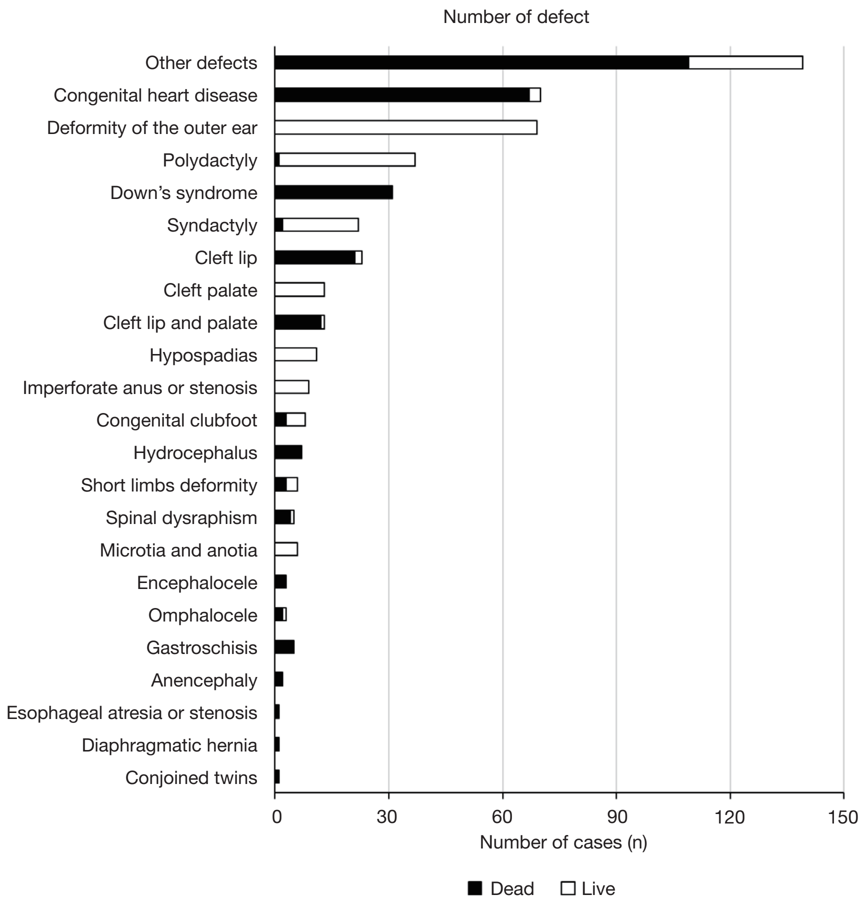

Figure 1 The types of birth defects in live births and stillbirths.

There was no significantly different distribution of defect type among different delivery years (2017 to 2020, P=0.070; *Table 3*).

Independent variables associated with birth defects during the whole of pregnancy

To investigate independent variables associated with birth defects during the whole of pregnancy, univariate and multivariate logistic regression models were performed. In univariate analysis, the cases with higher maternal age, gravidity, parity, preterm birth, CS, uterus scarring, and low birth weight were associated with birth defects (all P<0.001; *Table 4*). In multivariate analysis, preterm birth [odds ratio (OR): 1.69, 95% confidence interval (CI): 1.01 to 2.86], CS (OR: 1.46, 95% CI: 1.08 to 1.98), scarred uterus (OR: 1.70, 95%: 1.01 to 2.85), and low birth weight (OR >4 compared to other the two classes) remained significantly associated with all birth defect (all P<0.05; *Table 4*).

Independent variables associated with perinatal birth defects

Table 5 shows the univariate and multivariate analyses of independent variables associated with perinatal birth defects. In multivariate analysis, cases with CS (OR: 1.43, 95% CI: 1.05 to 1.93), gestational hypertension (OR: 1.70, 95%: 1.04 to 2.78), and low birth weight (OR >3.70 compared to other two classes) were more likely to have perinatal birth defects.

Discussion

This current study analyzed the surveillance data of birth defects during the perinatal period and the whole of pregnancy, as well as the independent influencing factors. The results demonstrated that the incidence of birth defects during the whole of pregnancy was 175.46/10,000, while the incidence of perinatal birth defects was 96.22/10,000. The perinatal birth defect rate of this study was lower

Table 3 Subgroup analysis of defect type stratified by different delivery years

Parameter	Delivery year, n (%)				P
	2017	2018	2019	2020	
Defect type					0.070
Other defects	31 (26.50)	37 (28.03)	40 (27.59)	31 (34.07)	
Congenital heart disease	16 (13.68)	23 (17.42)	18 (12.41)	13 (14.29)	
Deformity of the outer ear	21 (17.95)	14 (10.61)	29 (20.00)	5 (5.49)	
Polydactyly	9 (7.69)	6 (4.55)	14 (9.66)	8 (8.79)	
Down’s syndrome	8 (6.84)	10 (7.58)	6 (4.14)	7 (7.69)	
Syndactyly	1 (0.85)	6 (4.55)	11 (7.59)	4 (4.40)	
Cleft lip	5 (4.27)	11 (8.33)	5 (3.45)	2 (2.20)	
Cleft palate	6 (5.13)	4 (3.03)	3 (2.07)	0	
Cleft lip and palate	4 (3.42)	3 (2.27)	4 (2.76)	2 (2.20)	
Hypospadias	2 (1.71)	5 (3.79)	1 (0.69)	3 (3.30)	
Imperforate anus or stenosis	2 (1.71)	1 (0.76)	2 (1.38)	4 (4.40)	
Congenital clubfoot	2 (1.71)	3 (2.27)	3 (2.07)	0	
Hydrocephalus	1 (0.85)	3 (2.27)	1 (0.69)	2 (2.20)	
Short limbs deformity	1 (0.85)	2 (1.52)	2 (1.38)	1 (1.10)	
Spinal dysraphism	1 (0.85)	0	2 (1.38)	2 (2.20)	
Microtia and anotia	2 (1.71)	1 (0.76)	2 (1.38)	1 (1.10)	
Encephalocele	3 (2.56)	0	0	0	
Omphalocele	0	1 (0.76)	1 (0.69)	1 (1.10)	
Gastroschisis	2 (1.71)	1 (0.76)	0	2 (2.20)	
Anencephaly	0	1 (0.76)	1 (0.69)	0	
Esophageal atresia or stenosis	0	0	0	1 (1.10)	
Diaphragmatic hernia	0	0	0	1 (1.10)	
Conjoined twins	0	0	0	1 (1.10)	

than that of some regions in China, such as Dalian (10.114/10,000) (13), Jiangsu (155.49/10,000) (14), and Hunan (191.84/10,000) (15), but higher than other regions, such as Huai’an (46.35/10,000) (7). Meanwhile, the birth defect rate during the whole of pregnancy was lower than that of Zhejiang, China (3,043/10,000) (16), and certain reports in Europe (27182/10,000) (17), and the United States (3%) (18).

In this study cohort, congenital heart disease ranked first in all birth defects. It has been reported for more than a decade that congenital heart disease is the leading cause of perinatal birth defects in China, and its incidence has been increasing annually (19). A variety of influencing factors associated with congenital heart disease have been identified, such as the advanced age of pregnant parents, obesity, smoking and drinking, pre-pregnancy and pregnancy diseases, and exposure to various environmental teratogens under industrialization and urbanization (17,20-22), all of which have gradually elevated the incidence of congenital heart disease. Furthermore, with the widespread use of echocardiography, small defects (such as ventricular septal defect, atrial septal defect, and patent ductus arteriosus) are more likely to be identified (20,21,23), thereby increasing the diagnosis rate of congenital heart disease. The reduction

Table 4 Independent variables associated with birth defects during the whole of pregnancy

Parameters	Univariate		Multivariate	
	OR (95% CI)	P	OR (95% CI)	P
Maternal age (years)	1.07 (1.04 to 1.09)	<0.001	1.02 (0.99 to 1.06)	0.200
Gravidity	1.20 (1.11 to 1.30)	<0.001	0.94 (0.80 to 1.11)	0.490
Parity	1.51 (1.26 to 1.83)	<0.001	0.77 (0.48 to 1.22)	0.267
Preterm birth				
No	Ref.	–	Ref.	–
Yes	5.00 (3.45 to 7.69)	<0.001	1.69 (1.01 to 2.86)	0.046
Delivery method				
NSD	Ref.	–	Ref.	–
CS	3.21 (2.41 to 4.27)	<0.001	1.46 (1.08 to 1.98)	0.014
Scarred uterus				
No	Ref.	–	Ref.	–
Yes	1.71 (1.33 to 2.21)	<0.001	1.70 (1.01 to 2.85)	0.045
Diagnosis of newborn body weight		<0.001		<0.001
Low birth weight	Ref.	–	Ref.	–
Normal weight	0.11 (0.07 to 0.17)	<0.001	0.25 (0.14 to 0.45)	<0.001
Macrosomia	0.13 (0.07 to 0.27)	<0.001	0.17 (0.08 to 0.38)	<0.001

NSD, normal spontaneous delivery; CS, cesarean section; Ref., invalid reference; OR, odds ratio; CI, confidence interval.

in the incidence of neural tube defect-related birth defects is closely related to the nationwide folic acid supplementation program launched in China in 2009 (24-26).

The majority of cases with severe birth defects in our cohort, such as congenital heart disease, Down's syndrome, and digestive system malformations, were stillborn. This phenomenon is attributed to the implementation and promotion of pre-marital medical examinations, prenatal screening, prenatal diagnosis, and other birth defect prevention services in China (27). Most of these fetuses with severe and fatal birth defects can be diagnosed by prenatal screening and prenatal diagnosis. As a result, the majority of fetuses with congenital heart disease, Down's syndrome and digestive system malformations are selectively terminated in the second trimester for medical reasons (28). Many fetuses with cleft lip or mild congenital heart disease are also terminated due to the wishes of patients and their families. These terminated birth defects fetuses in the second trimester reduce the incidence of perinatal birth defects. Therefore, hospital monitoring of birth defects based on perinatal data underestimates the incidence of certain defects.

The results herein showed that compared with cases without birth defects, those with birth defects had significantly higher maternal age, gravidity, parity, rate of preterm birth, CS rate, scarred uterus, stillborn, and male newborns. Multivariate logistic regression model analysis revealed that preterm birth (OR: 1.69), CS (OR: 1.46), scarred uterus (OR: 1.70), and low birth weight (OR >4) were significantly associated with birth defects during the whole of pregnancy. The independent influencing factors associated with perinatal birth defects included CS (OR: 1.43), gestational hypertension (OR: 1.70), and low birth weight (OR >3.70).

In China, the CS rate has steadily declined from 2013 to 2018, largely due to the vigorous advocating of natural childbirth and appropriate midwifery techniques, and the strict control of surgical indications (29). As most CS cases are indicative, such as premature infants, macrosomia, scarred uterus, or urgent pregnancy termination because of pregnancy-related diseases, fetuses delivered by CS have a higher incidence of birth defects than those with normal spontaneous delivery. Since China implemented

Table 5 Independent variables associated with perinatal birth defects

Parameters	Univariate		Multivariate	
	OR (95% CI)	P	OR (95% CI)	P
Maternal age (years)	1.06 (1.03 to 1.10)	<0.001	1.01 (0.98 to 1.05)	0.529
Gravidity	1.10 (0.97 to 1.25)	0.142		
Parity	1.16 (0.85 to 1.57)	0.356		
Preterm birth				
No	Ref.	–	Ref.	–
Yes	0.20 (0.13 to 0.29)	<0.001	1.61 (0.95 to 2.72)	0.076
Delivery method				
NSD	Ref.	–	Ref.	–
CS	3.21 (2.41 to 4.27)	<0.001	1.43 (1.05 to 1.93)	0.022
Diabetes				
No	Ref.	–		
Yes	1.33 (0.91 to 1.95)	0.136		
Hypertension				
No	Ref.	–	Ref.	–
Yes	2.64 (1.67 to 4.17)	<0.001	1.70 (1.04 to 2.78)	0.033
Scarred uterus				
No	Ref.	–	Ref.	–
Yes	1.61 (1.09 to 2.38)	0.017	1.34 (0.88 to 2.04)	0.167
Diagnosis of newborn body weight		<0.001		<0.001
Low birth weight	Ref.	–	Ref.	–
Normal weight	0.11 (0.07 to 0.17)	<0.001	0.27 (0.15 to 0.48)	<0.001
Macrosomia	0.13 (0.07 to 0.27)	<0.001	0.19 (0.08 to 0.41)	<0.001

NSD, normal spontaneous delivery; CS, cesarean section; Ref., invalid reference; OR, odds ratio; CI, confidence interval.

a universal two-child policy in October 2015, the fertility rate of women with advanced age or scarred uterus has markedly risen (30,31). For women with a scarred uterus, most cases have advanced age, gestational diseases, multiple pregnancies, and birth history, hence women with a scarred uterus are more likely to have birth defects. Compared with normal fetuses, premature fetuses and those with low birth weight may have nutritional imbalances and imperfect development during pregnancy. Meanwhile, their mothers are more likely to have pregnancy-related diseases, and therefore, a higher incidence of birth defects (22,25,32,33). This study showed that hypertension during pregnancy is an independent factor associated with perinatal birth defects. Accumulating evidence has suggested that pregnancy diseases can affect the growth and development of the fetus through a variety of factors, leading to a high incidence of birth defects (34-37).

Although an increasing number of factors influencing birth defects have been identified, interventions to reduce birth defect occurrence are also increasing. But there was no significant change in the incidence of birth defects in this hospital from 2017 to 2020. Analyzing the reasons, with the implementation and promotion of echocardiography, prenatal screening, prenatal diagnosis, and other birth defect prevention services in China, an increasing number of birth defects are being monitored and diagnosed.

Limitation and future implementation

Several limitations to this study should be mentioned. Birth defects cause a further 170,000 deaths in children between the ages of 1 month and 5 years (1). Since the study subjects were limited to the cases under 7 days after birth, delayed-onset diseases were not included in this study. Environment pollution, especially cigarette smoking and air pollution, has been demonstrated by multiple studies to have a causal relationship with the occurrence of birth defects (38,39). In addition, our analysis of associated factors is not comprehensive. Moreover, we only analyzed 23 common birth defects and did not analyze rare and multiple deformities. Future multi-center studies should expand the time period of birth defects, increase the types of influencing factors, and separately analyze the influencing factors of each birth defect with ample data.

Conclusions

There was no significant change in the incidence of birth defects in this hospital from 2017 to 2020, and the epidemiological trend of birth defects is more consistent with the national trend. Preterm birth, CS, scarred uterus, and low birth weight were associated with birth defects during the whole of pregnancy. The independent influencing factors associated with perinatal birth defects included CS, gestational hypertension, and low birth weight.

The discovery and monitoring of known influencing factors associated with birth defects, such as, preterm birth, gestational hypertension, low birth weight, should be enhanced. For the controllable influencing factors, obstetrics providers should work with patients to minimize their risk of birth defects.

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Footnote

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