scientific reports

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Factors associated with preterm birth and low birth weight among infants with congenital heart disease in Changsha City, China, 2022–2024

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This study aimed to analyze the influencing factors for preterm birth (PTB) and low birth weight (LBW) among infants with congenital heart disease (CHD) in Changsha City and to provide a scientific basis for the development of targeted preventive measures. Data on infants with CHD were collected from all the birth defects (BDs) monitoring hospitals in Changsha City from January 1, 2022 to December 31, 2024. The diagnosis of BDs was coded according to the World Health Organization's International Classification of Diseases. CHD was classified under codes Q20-Q26 in the ICD-10. Multivariable binary logistic regression was used to identify factors associated with PTB and LBW among infants with CHD. 1,460 infants with CHD were included. The overall rates of PTB and LBW among infants with CHD were 15.89% and 14.38%, respectively. Maternal folic acid supplementation was identified as a protective factor for PTB in infants with CHD (aOR = 0.40, 95%CI: 0.23–0.67), while gestational diabetes mellitus (GDM) (aOR = 3.28, 95%CI: 1.44–7.48), and comorbidity with other BDs (aOR = 1.82, 95%CI: 1.36–2.44) were identified as risk factors. Minority ethnicity was identified as a protective factor for LBW among infants with CHD (aOR = 0.35, 95%CI: 0.14–0.89), while rural residence (aOR = 1.46, 95%CI: 1.02–2.08), history of spontaneous abortion (aOR = 1.96, 95%CI: 1.33–2.87), pregnancy-induced hypertension (aOR = 3.31, 95%CI: 1.03–10.67), female sex (aOR = 1.59, 95%CI: 1.18–2.16), and comorbidity with other BDs (aOR = 2.31, 95%CI: 1.70–3.13) were identified as risk factors. The rates of PTB and LBW among infants with CHD were relatively high in Changsha City. For PTB, maternal folic acid supplementation was a protective factor, whereas GDM and comorbidity with other BDs were risk factors. For LBW, minority ethnicity was a protective factor, whereas rural residence, history of spontaneous abortion, pregnancy-induced hypertension, female sex, and comorbidity with other BDs were risk factors. Further studies are needed to elucidate the determinants of PTB and LBW among infants with CHD, with analyses stratified by specific CHD subtypes.

Keywords Congenital heart disease, Preterm birth, Low birth weight, Infant

Congenital heart disease (CHD) is a structural abnormality of the heart or abnormal cardiovascular development at birth[1]. The incidence of CHD is estimated to be around 17–18 per 1,000 live births worldwide[2]. In China, the incidence is approximately 17.3‰, making CHD the most common birth defects (BDs) and a leading cause of neonatal mortality[3]. The reported incidence of CHD tends to be higher in developed regions, which is largely attributable to more advanced prenatal screening and diagnostic technologies that enhance detection capabilities[4]. From 1990 to 2021, the global age-standardized prevalence rate of CHD remained stable (estimated annual percentage change: 0.04%, 95% CI: 0.03%-0.05%)[5]. Analysis of the epidemiology of adverse

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pregnancy outcomes in infants with CHD has significant implications for clinical care and prevention, alongside contributing to the reduction of neonatal mortality.

Preterm birth (PTB) and low birth weight (LBW) are also important public health problems worldwide and are the major adverse pregnancy outcomes in perinatal health. CHD in infants is associated with various adverse pregnancy outcomes. Some studies have reported that infants with CHD have a higher risk of PTB and LBW than the general population[6,7]. In contrast, other studies suggested that PTB and LBW among infants with CHD may have higher risk factors for growth retardation[8,9]. Ishikawa et al. found that infants with a combination of CHD and LBW carried a higher risk of death beyond that of either alone[10]. Furthermore, adverse pregnancy outcomes are correlated with the subsequent growth and development of newborns. Shaw et al. found that PTB could be associated with poor neurodevelopment and behavioral outcomes[11]. Steurer et al. reported that PTB with a gestational age of 28–32 weeks have the highest mortality or morbidity compared with their peers without CHD[12]. Nakano et al. presented that LBW among infants might express adipose tissue maldevelopment and have a greater likelihood of developing insulin resistance and its associated comorbidities later in life[13]. While previous studies have linked CHD to adverse pregnancy outcomes such as PTB and LBW, most studies examined PTB and LBW separately or focus on narrow risk factors. Few studies have conducted comprehensive comparisons of demographic, obstetric, and neonatal factors for both PTB and LBW within the same CHD cohort in China. This hinders identification of shared and distinct etiological pathways needed for integrated prevention. Moreover, the majority of studies have been conducted in Western populations, and the findings may not be generalizable to Chinese populations due to significant differences in genetics, socioeconomic conditions, healthcare access, and maternal lifestyle.

Therefore, we conducted an epidemiological study on PTB and LBW among infants with CHD from the Birth Defects Surveillance System in Hunan Province, to describe the recent rates of PTB and LBW among infants with CHD in Changsha City, and identify the independent factors associated with PTB and LBW in this specific population, thereby filling a critical knowledge gap and informing region-specific preventive strategies.

Materials and methods

Data sources

This study utilized data on infants with CHD obtained from the Hunan Provincial Birth Defects Surveillance System. These data were collected from all monitoring hospitals in Changsha City from January 1, 2022 to December 31, 2024. The diagnosis of BDs was coded according to the World Health Organization's International Classification of Diseases. CHD was classified under codes Q20-Q26 in the ICD-10. Inclusion criteria: (1) diagnosis of CHD within seven days after birth; (2) singleton pregnancy; (3) live birth; (4) gestational age ≥ 28 weeks; (5) availability of comprehensive medical records. Exclusion criteria: (1) diagnosis of patent ductus arteriosus and/or patent foramen ovale solely due to prematurity; (2) diagnosis of isolated patent foramen ovale and/or patent ductus arteriosus (< 3 mm in diameter). Surveillance data included demographic characteristics, reproductive histories, maternal pregnancy information, newborn information, and other key information. Specifically, demographic characteristics included maternal age, ethnicity, education level, and residence. Reproductive histories included gravidity, parity, and history of stillbirth and spontaneous abortion. Maternal pregnancy information included maternal folic acid supplementation, mode of conception, pregnancy-induced hypertension, gestational diabetes mellitus (GDM), and threatened abortion. Newborn information included neonatal sex, and comorbidity with other BDs.

Definitions

PTB is defined as delivery occurring at a gestational age between 28 and 37 weeks. LBW is defined as a newborn weight less than 2,500 g when they were born.

Data quality control

To standardize the monitoring of BDs, the Changsha Municipal Health Commission organizes annual training courses related to BDs monitoring and carries out comprehensive quality control examinations each year. Additionally, comprehensive quality control inspections were conducted across the city. Data were meticulously collected and reported by experienced doctors, and subsequently reviewed by senior doctors to ensure accuracy and reliability. Finally, the supervisor and technical guidance departments checked and reviewed the collected data for completeness and accuracy.

Statistical analysis

Continuous data are presented as mean ± standard deviation. Categorical data are presented as frequencies and percentages, and inter-group comparisons are conducted using Chi-square tests.

Multivariable binary logistic regression analysis was used to identify factors associated with PTB and LBW among infants with CHD, and the results are presented as adjusted odds ratios (aORs) with 95% confidence intervals (CIs). In model 1, the dependent variable was PTB (yes = 1, no = 0). In model 2, the dependent variable was LBW (yes = 1, no = 0). A P value of less than 0.05 was considered significant.

Ethics approval and consent to participate

This study was approved by the Changsha Hospital for Maternal & Child Health Care Affiliated to Hunan Normal University (NO: EC-20240625-19). The requirement for informed consent was waived by the Changsha Hospital for Maternal & Child Health Care Affiliated to Hunan Normal University due to the retrospective nature of the study. We confirmed that all methods were performed in accordance with the relevant guidelines and regulations.

Results

Rates of PTB and LBW among infants with CHD

A total of 238,144 live births were included in this study. Among them, 3,469 cases with BDs and 1,460 infants with CHD were identified. The overall rates of PTB and LBW among infants with CHD were 15.89% and 14.38%, respectively. From 2022 to 2024, the rates of PTB in infants with CHD were 14.11%, 16.04%, and 18.10%, respectively, and remained generally steady ($\chi^2_{trend} = 2.865$, $P = 0.091$). From 2022 to 2024, the rates of LBW among infants with CHD were 12.14%, 14.58%, and 17.14%, respectively, and showed an upward trend ($\chi^2_{trend} = 4.891$, $P = 0.027$) (Table 1).

Characteristics of the study population

Among 1,460 infants with CHD, 445 infants (30.5%) were comorbid with other BDs. Among this subgroup, 22.0% (98/445) were PTB and 22.2% (99/445) had LBW. The average maternal age was 30.9 ± 5.0 years, ranging from 17 to 55 years, and 38.0% of them were aged 30–34 years. The majority of ethnic groups were the Han ethnicity (94.6%). The largest proportion of mothers (73.9%) held a college degree or above. The majority (79.4%) resided in urban areas. About 37.0% of mothers were primigravidae and 56.9% were primipara. The proportions of mothers with no history of stillbirth and no history of spontaneous abortion were 97.1% and 85.9%, respectively. Folic acid supplementation was reported by 94.9% of mothers, and 91.6% of all mothers had a natural conception. Moreover, 99.1% had no pregnancy-induced hypertension, 98.2% had no GDM, and 98.9% had no threatened abortion. Among the infants, 52.2% were male, and 69.5% had no other BDs (Table 2).

Univariate analysis for PTB and LBW among infants with CHD

Univariate analysis identified the following factors associated with PTB in infants with CHD: education level, gravidity, stillbirth history, spontaneous abortion history, maternal folic acid supplementation, pregnancy-induced hypertension, GDM, and comorbidity with other BDs. Similarly, factors associated with LBW included: ethnicity, education level, residence, spontaneous abortion history, pregnancy-induced hypertension, GDM, comorbidity with other BDs, and neonatal sex (Table 2).

Multivariable binary logistic regression analysis for PTB in infants with CHD

Multivariable binary logistic regression analysis identified maternal folic acid supplementation as a protective factor for PTB in infants with CHD (aOR = 0.40, 95%CI: 0.23–0.67), while GDM (aOR = 3.28, 95%CI: 1.44–7.48) and comorbidity with other BDs (aOR = 1.82, 95%CI: 1.36–2.44) were identified as risk factors (Table 3).

Multivariable binary logistic regression analysis for LBW among infants with CHD

Multivariable binary logistic regression identified minority ethnicity as a protective factor for LBW among infants with CHD (aOR = 0.35, 95%CI: 0.14–0.89), while rural residence (aOR = 1.46, 95%CI: 1.02–2.08), history of spontaneous abortion (aOR = 1.96, 95%CI: 1.33–2.87), pregnancy-induced hypertension (aOR = 3.31, 95%CI: 1.03–10.67), female sex (aOR = 1.59, 95%CI: 1.18–2.16), and comorbidity with other BDs (aOR = 2.31, 95%CI: 1.70–3.13) were identified as significant risk factors (Table 4).

Discussion

Overall, we have described a contemporary population-based analysis using robust 2022–2024 surveillance data from Changsha, reflecting current medical and demographic trends. We performed a comprehensive, concurrent evaluation of potential risk factors for PTB and LBW in CHD infants across sociodemographic, reproductive, behavioral, clinical, and neonatal domains, and identified independent associated factors specific to this population, thereby providing actionable insights for targeted intervention.

This study found that the overall rates of PTB and LBW among infants with CHD in Changsha City between 2022 and 2024 were 15.89% and 14.38%, respectively, which are lower than those reported in previous studies for this population. For example, Olugbuyi et al. reported that the rates of PTB and LBW among infants with CHD in Canada (2008–2018) were 18.9% and 17.9%, respectively[14]. Mustafa et al. found that the PTB rate in infants with CHD was 23.2% between 2011 and 2016[15]. Palma et al. found that the PTB rate in infants with CHD was 23% between 2003 and 2017[16]. However, the rates of PTB and LBW among infants with CHD in Changsha City were higher than those reported for the general population in previous studies. For instance, in general infants, the rate of PTB was 6.27% in Shanghai City in 2020[17], and the rate of LBW was 7.7% in Ghana in 2017[18]. Some previous studies found that CHD in fetuses would have an increased risk of adverse pregnancy outcomes such as stillbirths, neonatal deaths, PTB, and LBW[15,19,20]. The underlying reason may be that the

Year	Number of live births (*n*)	Number of BDs (*n*)	Number of CHD (*n*)	PTB in infants with CHD		LBW infants with CHD	
				Number	Rate (%)	Number	Rate (%)
2022	79,255	1156	560	79	14.11	68	12.14
2023	75,719	1104	480	77	16.04	70	14.58
2024	83,170	1209	420	76	18.10	72	17.14
Total	238,144	3469	1460	232	15.89	210	14.38

Table 1. Rates of PTB and LBW among infants with CHD in Changsha City, China, 2022–2024. *BDs* birth defects, *CHD* congenital heart disease, *PTB* preterm birth, *LBW* low birth weight.

Characteristics	Frequency ($n = 1460$)	Proportion (%)	PTB			LBW		
			Number (%)	χ^2	*P* value	Number (%)	χ^2	*P* value
Maternal age (years)				8.336	0.080		4.008	0.405
< 20	10	0.7	3 (30.0)			3 (30.0)		
20–24	136	9.3	19 (14.0)			22 (16.2)		
25–29	424	29.0	59 (13.9)			58 (13.7)		
30–34	555	38.0	83 (15.0)			73 (13.2)		
≥ 35	335	22.9	68 (20.3)			54 (16.1)		
Ethnicity				0.242	0.623		6.675	0.010
Han ethnicity	1381	94.6	221 (16.0)			205 (14.8)		
Minority ethnicity	79	5.4	11 (13.9)			5 (6.3)		
Education level				7.934	0.019		7.533	0.023
Primary school or below	10	0.7	3 (30.0)			3 (30.0)		
Middle school	371	25.4	74 (20.0)			67 (18.1)		
College or above	1079	73.9	155 (14.4)			141 (13.1)		
Residence				1.610	0.205		6.384	0.012
Urban	1159	79.4	177 (15.3)			153 (13.2)		
Rural	301	20.6	55 (18.3)			57 (18.9)		
Gravidity				9.973	0.019		1.010	0.799
Primigravidae	540	37.0	73 (13.5)			77 (14.3)		
1 previous pregnancy	382	26.2	54 (14.1)			50 (13.1)		
2 previous pregnancies	283	19.4	50 (17.7)			44 (15.5)		
≥ 3 previous pregnancies	255	17.5	55 (21.6)			39 (15.3)		
Parity				2.111	0.146		2.035	0.154
Primipara	831	56.9	122 (14.7)			129 (15.5)		
Pluripara	629	43.1	110 (17.5)			81 (12.9)		
Stillbirth history				5.203	0.023		0.764	0.382
Yes	42	2.9	12 (28.6)			8 (19.0)		
No	1418	97.1	220 (15.5)			202 (14.2)		
Spontaneous abortion history				6.362	0.012		10.842	0.001
Yes	206	14.1	45 (21.8)			45 (21.8)		
No	1254	85.9	187 (14.9)			165 (13.2)		
Maternal folic acid supplementation				56.015	0.000		0.048	0.827
Yes	1386	94.9	209 (15.1)			200 (14.4)		
No	74	5.1	23 (31.1)			10 (13.5)		
Mode of conception				0.159	0.690		0.007	0.934
Natural conception	1337	91.6	214 (16.0)			192 (14.4)		
Assisted reproduction	123	8.4	18 (14.6)			18 (14.6)		
Pregnancy-induced hypertension				8.988	0.003		6.175	0.013
Yes	13	0.9	6 (46.2)			5 (38.5)		
No	1447	99.1	226 (15.6)			205 (14.2)		
GDM				10.090	0.001		5.771	0.016
Yes	26	1.8	10 (38.5)			8 (30.8)		
No	1434	98.2	222 (15.5)			202 (14.1)		
Threatened abortion				2.856	0.091		1.481	0.224
Yes	16	1.1	5 (31.3)			4 (25.0)		
No	1444	98.9	227 (15.7)			206 (14.3)		
Comorbidity with other BDs				18.009	0.000		32.142	0.000
Yes	445	30.5	98 (22.0)			99 (22.2)		
No	1015	69.5	134 (13.2)			111 (10.9)		
Neonatal sex				0.089	0.765		7.714	0.005
Male	762	52.2	119 (15.6)			91 (11.9)		
Female	698	47.8	113 (16.2)			119 (17.0)		

Table 2. Univariate analysis for PTB and LBW among infants with CHD in Changsha City.

Characteristics	β	SE	Wald χ2	*P* value	aOR	95% CI
Maternal folic acid supplementation						
Yes	−0.93	0.27	11.98	0.001	0.40	0.23–0.67
No					1.00	
GDM						
Yes	1.19	0.42	8.00	0.005	3.28	1.44–7.48
No					1.00	
Comorbidity with other BDs						
Yes	0.60	0.15	16.08	0.000	1.82	1.36–2.44
No					1.00	

Table 3. Multivariable binary logistic regression of PTB in infants with CHD in Changsha City.

Characteristics	β	SE	Wald χ2	*P* value	aOR	95% CI
Ethnicity						
Han ethnicity					1.00	
Minority ethnicity	−1.05	0.47	4.89	0.027	0.35	0.14–0.89
Residence						
Urban					1.00	
Rural	0.38	0.18	4.37	0.037	1.46	1.02–2.08
Spontaneous abortion history						
Yes	0.67	0.20	11.70	0.001	1.96	1.33–2.87
No					1.00	
Pregnancy-induced hypertension						
Yes	1.20	0.60	4.01	0.045	3.31	1.03–10.67
No					1.00	
Comorbidity with other BDs						
Yes	0.84	0.16	28.76	0.000	2.31	1.70–3.13
No					1.00	
Neonatal sex						
Male					1.00	
Female	0.47	0.16	9.06	0.003	1.59	1.18–2.16

Table 4. Multivariable binary logistic regression of LBW among infants with CHD in Changsha City.

pathophysiological stress of CHD in the fetus can trigger mechanisms that lead to preterm labor and impaired fetal growth. However, these mechanisms require further investigation. From 2022 to 2024, the rate of PTB in infants with CHD remained generally steady ($\chi^2_{trend} = 2.865$, $P = 0.091$), yet the rate of LBW among infants with CHD showed an upward trend ($\chi^2_{trend} = 4.891$, $P = 0.027$). We speculate that this increase may be attributable to improved survival rates among LBW infants with CHD, potentially due to incremental refinements in perinatal and neonatal care.

Several factors associated with PTB and LBW among infants with CHD were identified in this study. First, maternal folic acid supplementation was identified as a protective factor for PTB in infants with CHD, which is consistent with a previous study[21]. Wu et al. found that folic acid supplementation for at least 3 months during pregnancy was associated with a 20% lower risk of PTB compared with no supplementation[22]. Bortolus et al. reported that folic acid 4.0 mg versus 0.4 mg daily supplementation started before pregnancy to 12th gestational week was associated with fewer spontaneous abortions, PTB and with a better composite outcome[23]. However, a systematic review and meta-analysis of randomized controlled trials reported that folic acid supplementation during pregnancy did not prevent PTB[24]. In this study, folic acid supplementation was not associated with LBW infants with CHD. The lack of association could be explained by several factors. First, the preventive effect of folic acid on fetal growth restriction seems to be limited. For instance, a previous study reported that cumulative folic acid supplementation for more than 4 months was a protective factor for the delivery of small-for-gestational-age infants[25]. Second, it may also be influenced by the timing of folic acid supplementation during pregnancy, the dosage taken, and interactions with other nutritional supplements. Furthermore, the etiology of LBW is highly complex. Beyond gestational age, it is strongly influenced by factors such as placental function, maternal nutritional status, and other pregnancy complications. The confounding effects of these factors may have obscured a protective effect of folic acid per se.

Second, GDM was identified as a risk factor for PTB in infants with CHD. This finding is consistent with the general newborn population[26], indicating that the adverse effect of GDM on pregnancy outcomes remains significant even in the presence of CHD. Lin et al. reported that pregnant women with GDM have a higher

risk of LBW (aOR = 1.18, 95%CI: 1.06–1.32)[27]. This may occur because high amniotic glucose levels in GDM promote increased amniotic fluid secretion by the amnion, which in turn raises the risk of premature rupture of membranes (PROM) and can lead to PTB.

Third, comorbidity with other BDs was identified as a risk factor for both PTB and LBW among infants with CHD. Dolan et al. reported that a singleton liveborn infant with BDs was 2.7 times more likely to be delivered preterm before 37 weeks of gestation and 3.6 times more likely to have a LBW at less than 2,500 g[28]. Our findings strongly align with and extend the work of Adam et al., who recently reported elevated risks of PTB and LBW in infants with major congenital anomalies[29]. By focusing specifically on infants with CHD who have additional BDs, we demonstrate that the cumulative burden of congenital malformations significantly exacerbates the risk of adverse perinatal outcomes, even when the primary defect is cardiac in nature. This underscores the importance of enhanced prenatal monitoring for pregnancies where CHD is diagnosed alongside other anomalies.

Fourth, spontaneous abortion history was identified as a risk factor for LBW infants with CHD. This association is notably aligned with the report by Sun et al., who demonstrated that pregnant women with a history of spontaneous abortion had significantly higher odds of PTB (aOR = 1.38, 95%CI: 1.07–1.79) compared to those without such a history[30]. Given that PTB is a leading cause of LBW, we postulate that the observed link between spontaneous abortion history and LBW in infants with CHD is likely mediated, at least in part, by an increased rate of PTB. The association may be driven by the mechanism of cervical insufficiency in women with prior spontaneous abortion, which can cause painless second-trimester dilation and lead to PTB or prelabor rupture of membranes.

Fifth, pregnancy-induced hypertension was identified as a risk factor for LBW infants with CHD. This finding is consistent with previous studies of the general population[31–33]. A meta-analysis showed that the odds of LBW increased nearly four times among women with pregnancy-induced hypertension than normotensive women[34]. The underlying mechanism is thought to involve vascular endothelial injury and microthrombus formation, which impairs placental exchange function. A key consequence is hypertension-induced insufficient utero-placental perfusion, leading to fetal intrauterine growth restriction and LBW[35]. Therefore, systematic monitoring and management of blood pressure during pregnancy is crucial for reducing the risk of LBW.

Sixth, minority ethnicity was identified as a protective factor for LBW in infants with CHD. This finding is consistent with a prior local study reporting an association between ethnicity and birth weight in Changsha's general population[36]. While studies in other contexts, such as the United States, have highlighted how maternal anthropometry, gestational weight gain, and parental ethnicity collectively shape ethnic disparities in LBW rates[37], the protective effect observed in our setting likely arises from a distinct set of factors. These may include unique genetic backgrounds, cultural practices, socioeconomic profiles, lifestyle patterns, and dietary habits prevalent among the minority ethnic groups in our region.

Seventh, mothers living in rural areas had a higher risk of LBW infants with CHD. Yan et al. reported that maternal place of residence was associated with birth weight among infants with CHD[21], which is consistent with our study. Some previous studies of the general population reported that mothers living in rural areas had a higher risk for LBW than in urban areas such as in Changsha City[38], in India[39]. A previous study in Tanzania reported that area of residence was found to be maternal factors associated with LBW[40]. This disparity may be attributed to socioeconomic inequalities, including lower average incomes, poorer access to prenatal care and health education, and differences in nutritional awareness among women in rural areas compared to their urban counterparts. Moreover, female sex was identified as a risk factor for LBW infants with CHD, which is consistent with some previous studies of the general population such as in Changsha City[41], Guangxi Province[42], Kenya[43]. However, some previous studies reported that male sex was a significant risk factor for LBW[44,45].

Limitation

Our study has limitations. First, the retrospective design, reliant on surveillance data, inherently lacks control over potentially confounding variables. Notably, important risk factors such as PROM, maternal smoking, or fetal growth restriction, were not available for analysis. The absence of these variables may lead to residual confounding. Second, we analyzed CHD as a collective entity without further classification. CHD encompasses a wide spectrum of defects with vastly different hemodynamic impacts. This lack of stratification limits the clinical specificity of our results. Finally, regarding folic acid, our data only captured supplementation as a binary variable (yes/no). Information on the timing, duration, and dosage of supplementation was not available, which might explain the lack of an observed protective effect against LBW and deserves further investigation.

Conclusion

In summary, our data indicated that the rates of PTB and LBW among infants with CHD were relatively high in Changsha City. For PTB, maternal folic acid supplementation was a protective factor, whereas GDM and comorbidity with other BDs were risk factors. For LBW, minority ethnicity was a protective factor, whereas rural residence, history of spontaneous abortion, pregnancy-induced hypertension, female sex, and comorbidity with other BDs were risk factors. Further studies are needed to elucidate the determinants of PTB and LBW among infants with CHD, with analyses stratified by specific CHD subtypes.

Data availability

All data generated or analyzed during this study are included in this published article.

Received: 12 April 2025; Accepted: 21 January 2026
Published online: 27 January 2026

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Acknowledgements
The authors are grateful to all staff participating in the research.

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Jin Fu: Manuscript preparation, data collection, study design, statistical analysis, writing and editing. Jing Liu: Study design, statistical analysis, and writing. Bei Zhang, Jinlian Wang, and Yongchun Wen: Data collection. Jie Fang: Manuscript revision. Huan Chen: Manuscript preparation, study design, review, and editing. All authors reviewed and approved the final manuscript.

Declarations

Competing interests
The authors declare no competing interests.

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