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Analysis of Influencing Factors of Congenital Heart Disease in Newborns

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Abstract

This study examined the risk and protective factors associated with congenital heart disease (CHD) in newborns at a tertiary hospital in Guangzhou, China, with the aim of informing effective intervention strategies. Data were collected from 32 newborns diagnosed with CHD (case group) and 32 healthy newborns (control group) born between January 2021 and December 2023. Utilizing the Congenital Heart Disease Risk Factor Questionnaire and multivariable logistic regression analysis, researchers identified three key factors influencing CHD risk. Maternal health issues (OR=3.490) and exposure to passive smoking (OR=2.979) emerged as significant risk factors, while prenatal supplementation of folic acid and vitamins (OR=0.281) was identified as protective. The findings underscore the importance of managing maternal health and ensuring adequate prenatal supplementation to mitigate the risk of CHD in newborns.

Keywords

Newborns; Congenital heart disease; Risk factors; Protective factors.

1. INTRODUCTION

Congenital heart disease (CHD) is one of the most common congenital malformations that affect the quality of the population at birth. The incidence of CHD in live births in China is approximately 8% [1], and the pathogenesis of congenital heart disease is complex, with numerous influencing factors and unclear etiology. The influencing factors vary from region to region or from population to population [2]. With the development of the economy and urbanization in China, people's living environment and lifestyle have undergone significant changes. The age composition of pregnant women, their physiological and psychological conditions, and the environmental factors they are exposed to have all changed significantly. Therefore, in the face of new circumstances, it is of great significance for various regions to study the incidence and influencing factors of CHD.

2. MATERIALS AND METHODS

2.1. Case selection

Select live births born in a tertiary hospital in Guangzhou, China from January 2021 to December 2023, and conduct physical examinations on the newborns while they are asleep and without fever. If signs such as heart murmurs, rapid breathing, cyanosis of the lips, feeding difficulties, SpO_2 <95%, etc. are present, perform an echocardiogram to determine the presence of cardiovascular structural abnormalities. Infants with CHD are included in the case group. The case group is matched 1:1 with a control group of healthy live births born in the same hospital,

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with matching conditions of no congenital anomalies; same gender as the matched CHD infant, similar birth date, and parents' place of residence.

2.2. Table Survey

The parents of infants and young children in the case group and control group participated in the survey and completed the "Congenital Heart Disease Risk Factors Survey Form". The content of the survey form mainly includes the child's parents' place of residence, age, occupation, education level, average monthly family income, whether the mother has underlying diseases, the mother's parity, history of miscarriage, severe early pregnancy vomiting, threatened miscarriage, intense psychological stress during pregnancy, exposure to special substances by parents in the 3 months before pregnancy and the mother in the first 3 months of pregnancy, whether they actively smoke, passive smoking, alcohol consumption, pet raising, etc., whether the mother had colds, fever, hypertension, diabetes during pregnancy, whether she took sulfonamides, antibiotics, contraceptives, sedatives, etc., whether there is a family history of genetic diseases, whether the residence was renovated within the past 6 months, distance from the residence to the road <50 meters, and the number of times per week the pregnant woman cooks at home.

2.3. Statistical Analysis

Using Epidata3.1 software for data entry and SPSS 19.0 software for data analysis. Conducting single-factor logistic regression analysis on the relevant statistical results, including variables with $P<0.1$ in the single-factor analysis into a multiple-factor conditional logistic regression model, calculating the odds ratio (OR) and its 95% confidence intervals (CI) for the exposure factors, with $P<0.05$ considered statistically significant differences.

2.4. Ethical Review

The study has been approved by the hospital's medical ethics committee, and all parents of the children in the case group and control group have been informed of the research objectives and have signed informed consent forms.

3. RESULTS

3.1. Congenital heart disease in newborns

A total of 7650 live newborns were involved in the screening, with 32 newborns diagnosed with CHD, yielding a total detection rate of 4.18‰. Among them, there were 19 males and 13 females, with no statistically significant difference in detection rates between the two genders ($\chi2=0.496$, $P>0.05$). There were 28 cases of simple CHD and 4 cases of complex CHD, accounting for 68.8% and 31.2% of the total included cases, respectively. Among the simple type, the number of Patent Ductus Arteriosus (PDA) cases was the highest, followed by Atrial Septal Defect (ASD) and Ventricular Septal Defects (VSD) (see Table 1).

Table 1. The type of congenital heart disease

Diagnosis	Number of Cases	Percentage (%)
VSD	5	15.6
ASD	7	21.9
PDA	16	50
Complex CHD	4	12.5
Total	32	100

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3.2. Single-factor Logistic regression analysis

The case group and the control group were matched 1:1, with a total of 32 pairs of newborns. Disease status (1 for the case group, 0 for the control group) was used as the dependent variable. 33 influencing factors were included in the study, and single-factor logistic binary regression analysis was conducted. 14 influencing factors with P value <0.1 were selected (as shown in Table 2). Maternal age, maternal education level, average monthly income per household, parents' past medical history, parity, history of abortion, severe vomiting during pregnancy, cold and fever in early pregnancy, threatened abortion, passive smoking, paternal smoking, paternal alcoholism, and living <50 meters from the road were identified as possible risk factors, while supplementation with folic acid, vitamins, and calcium may be protective factors. Other factors had P values greater than 0.1 and were not statistically significant.

Table 2. Univariate logistic regression analysis of influencing factors of neonatal congenital heart disease

Factors	B	χ2	P value	OR	95%CI	
					Lower limit	Upper limit
Mother's age	0.782	3.818	0.054	2.186	0.988	4.836
Mother with underlying diseases	1.072	7.194	0.009	2.922	1.311	6.512
History of miscarriage	1.101	10.175	0.002	3.009	1.514	5.978
Early pregnancy cold and fever	0.972	7.590	0.007	2.644	1.312	5.329
Passive smoking by mother	1.088	10.067	0.002	2.969	1.502	5.870
Supplementing folic acid, vitamins, etc.	-1.183	8.420	0.005	0.306	0.135	0.697

3.3. Multiple regression analysis

To further explore the impact of various factors on the occurrence of CHD, and to eliminate the interference of all kinds of confounding factors, the 6 meaningful factors from the above single-factor Logistic binary regression analysis were selected as independent variables and all included in the multiple-factor Logistic binary regression analysis. Variables with P<0.05 were included, and those with P>0.1 were excluded. Finally, the OR value and 95% confidence interval were calculated. The multiple-factor Logistic regression analysis selected 3 influencing factors, including 2 independent risk factors and 1 protective factor (as shown in Table 3), specifically, maternal underlying diseases (OR=3.490, 95%CI:1.320-9.222) and maternal passive smoking (OR=2.979, 95%CI:1.285-6.907) as independent risk factors, while supplementation of folic acid, vitamins, etc. (OR=0.281, 95%CI:0.110-0.717) as a protective factor.

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Table 3. Multivariate logistic regression analysis of influencing factors of neonatal congenital heart disease

Factors	B	S. E	P value	OR	95% CI	
					Lower Limit	Upper Limit
Maternal underlying diseases	1.250	0.496	0.012	3.490	1.320	9.222
Maternal passive smoking	1.092	0.429	0.011	2.979	1.285	6.907
Supplementing folic acid, calcium	-1.269	0.478	0.008	0.281	0.110	0.717

4. DISCUSSION AND CONCLUSION

During pregnancy, if the mother has underlying diseases, it will increase the risk of congenital heart defects in the fetus. Studies by multiple scholars have shown that if the mother has underlying diseases such as lupus erythematosus [3], hypertension during pregnancy [4], and a history of congenital heart disease [5], the risk of CHD in their offspring also significantly increases. The reasons may stem from the impact of the disease on the body and may also come from the drugs used to treat related chronic diseases [6].

Exposure to tobacco during pregnancy is recognized as a toxic and potential teratogenic factor for fetal development. Due to the large smoking population in China, even if pregnant women have a low prevalence of active smoking habits, they are often exposed to secondhand smoke, which can have adverse effects on the cardiovascular system development of the fetus. Nicotine and carbon monoxide in cigarettes can affect the oxygenation capability of the blood by influencing endothelial cells and hemoglobin, leading to fetal hypoxia in utero. Additionally, toxic and addictive substances in cigarettes can cross the placental barrier through the bloodstream, affecting the development of the embryonic heart and ultimately causing abnormalities in heart structure and function [7]. Some scholars have quantified maternal smoke exposure with nicotine concentration in maternal hair, demonstrating a dose-response relationship between maternal smoke exposure and fetal congenital heart disease (CHD) [8]. Therefore, pregnant women should avoid tobacco exposure during preconception and throughout pregnancy.

During the perinatal period, a complete dietary structure and comprehensive supplementation of nutrients are crucial for the growth of the fetus, while the lack of certain nutrients may lead to congenital malformations in the fetus. This study suggests that supplementation of folic acid, complex vitamins, etc., before and during pregnancy is a protective factor for newborns with CHD. Folic acid is essential for cell division, growth, and the synthesis of nucleic acids, amino acids, and proteins, and is a necessary substance for the differentiation and growth of human cells. High-dose folic acid supplementation in early pregnancy can reduce the risk of CHD in fetuses [9]. In addition to folic acid, the intake of other vitamins is also very important for women during the perinatal period. Research by Dutch scholar Koster et al. indicates that the lack of maternal vitamin D during the perinatal period is related to the onset of CHD in offspring [10]. Studies have also shown that pregnant women who regularly intake multiple vitamins from 3 months before pregnancy to the first 3 months of pregnancy have a significantly reduced risk of their offspring developing CHD compared to those who do not intake adequate vitamins during the same period (OR = 0.76, 95% CI: 0.60-0.97). Therefore, balanced nutritional intake during the perinatal period and early supplementation of adequate folic acid and vitamins play a very important role in reducing the risk of CHD in offspring.

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To promote the policy of eugenics and reduce the birth rate of CHD fetuses, we need to increase the propaganda efforts of the government and media, actively treat underlying diseases before conception for childbearing-age women, try to avoid exposure to smoking environments and remind pregnant women to develop good lifestyle and dietary habits and supplement folic acid, vitamins, etc. appropriately.

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