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The risk factors of adverse pregnancy outcome for pre-pregnancy couples in Hunan, China

A cross-sectional study based on population

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Abstract

To identify the prevalence of chronic disease and behavior risk factors of adverse pregnancy outcome for pre-pregnancy couples in Hunan province, China.

A retrospective study including cross-sectional datas from the Free Pre-pregnancy Health Check (FPHC) surveillance system of Hunan, China in 2019 was conducted. Microsoft Excel 2010 was used for preliminary data analysis. The fowllowing descriptive analysis, t-tests, and Chi-Squared tests were carried out using SPSS 25.0.

Among 419,971 couples, 182,450 (21.72%) individuals were older than 35 years, 257,471(69.48%) couples planned to have a second or additional child and 114,892 (27.36%) individuals had a history of adverse pregnancy outcomes. The mean number of risk factors of adverse pregnancy outcome was higher in males than that in females (2.17 per male vs 1.92 per female). The prevalence/proportions of hypertension, increased psychological pressure, high alanine transaminase or creatinine, smoking, passive smoke exposure, alcohol use, and exposure to environmental risk factors were higher in males than that in females (2.43% vs 1.35%, 0.68% vs 0.54%, 12.80% vs 5.93%, 2.52% vs 1.47%, 27.70% vs 0.24%, 10.94% vs 3.58%, 15.62% vs 1.07%, and 1.46% vs 1.15%, respectively). The proportion of females with an abnormal cervix was 3.35%, and the proportion of males with abnormal wrapping was 1.90%. The prevalence/proportions of anemia and work-related pressure or social tensions were higher in females than that in males (5.53% vs 0.51%, 15.39% vs 13.61%, and 8.22% vs 7.88%, respectively).

History of adverse pregnancy outcomes and age olderthan 35 years were important risk factors for pre-pregnancy couples in Hunan province. The mean number of risk factors was higher in males than that in females. Hypertension, increased psychological pressure, high alanine transaminase and creatinine levels, smoking, passive smoke exposure, alcohol use, and exposure to dangerous environmental factors were the major risk factors for males. Anemia, work-related pressure and social tensions were the major risk factors for females.

Abbreviations: BDs = birth defects, FPHC = Free Pre-pregnancy Health Check, HMC = Health Ministry of China, PRAMS = Pregnancy Risk Assessment Monitoring System, WHO = World Health Organization.

Keywords: behavior, chronic disease, pre-pregnancy health check, risk factors

1. Introduction

According to the estimate of World Health Organization (WHO) estimates, the total prevalence rates of birth defects (BDs) in developed, middle-income and low-income countries are 47.2, 55.7 and 64.2 per 1000 live births, respectively.[1,2] The prevalence rate of BDs in China is approximately 56.0 per 1000 live births, which is closer to the level of middle-income countries. In recent years, the prevalence of BDs in Hunan

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province was highest among other areas in China.[3] Therefore, searching for risk factors of BDs and creating intervention programs in china, specifically in Hunan province, are quite important.

Pre-pregnancy health checks can potentially improve the health and pregnancy outcomes of couples.[4] Evidence-based interventions can correct many behaviors and chronic conditions of couples that are associated with adverse pregnancy outcomes, such as tobacco use, alcohol use, inadequate folic acid intake, obesity, hypertension, and diabetes.[5] Some countries, such as USA and Ireland, have set up Pregnancy Risk Assessment Monitoring System (PRAMS) to monitor maternal behaviors and experiences before, during and after pregnancy.[6] The main purposes of PRAMS are to promote the collection, analysis, and dissemination of population-based data of high scientific quality and to support the use of data to develop policies and programs that aim to decrease maternal and infant morbidity, mortality and BDs.[7] So, there were some researches focusing on the risk factors of adverse pregnancy outcome, but few of them concentrate on the situations in China. In addition, most of them = lack in comprehensive health status analysis of pre-pregnancy couples. The Health Ministry of China (HMC) initiated an FPHC program in 2010. This program includes free education, risk factor screening, physical examinations, laboratory examinations, and impact tests for pregnant women. To date, the HMC has spent 5 billion RMB for 8.35 million couples who plan to have pregnancy.[8] However, few reports have described the results of this program in public magazine.

Hunan is a province with a large population in China. There are approximately 7 hundred thousand babies born every year in Hunan. This study aimed to comprehensively describe and analyze the pre-pregnancy health conditions of couples in Hunan Province.

2. Methods

2.1. Participants, sample and ethics statement

All couples planning to have pregnancy and undergoing an FPHC in Hunan province in 2019 were included in this study. Thus, the study subjects constituted a non-selected population consisting of 419,971 couples. All couples signed informed consent forms before the health examination. All records for couples were anonymized prior to analysis. According to governmental requirements, we collected and analyzed these datas to inform the creation of policies designed to improve the health and pregnancy outcomes of couples. Our study was observational in nature, and mainly involves monitoring methods that would not disturb the participants. The study was approved by the Medical Ethics Committee of the Maternal and Children's Hospital of Hunan.

2.2. Study design and setting

Our research was a cross-sectional study based on population. This program of FPHC included collecting basic information (social demographic characteristics, lifestyle habits, family history, diet and nutrition, and exposure to environmental hazards), disease history, and socio-psychological factors, health education, physical examinations, laboratory examinations (vaginal secretion, routine blood tests, blood typing, routine urine tests, serum glucose, liver function, and hepatitis B serology), ultrasound at the department of gynecology, risk assessment and advisory guidance. This free health examination was mainly undertaken by area maternal and child health hospitals. Among these items, a history of adverse pregnancy outcomes included stillbirth, spontaneous abortion, and induced abortion. The criteria for chronic disease were as follows: anemia: Hb <110 g/L in females and <120 g/L in males; positive blood sugar screening: fasting blood glucose >6.1 mmol/L; hypertension: systolic pressure >140 mm Hg or diastolic pressure >90 mm Hg; high alanine transaminase level >50 U/L in males and >40 U/L in females; high creatinine level: >115 umol/L in males and >97 umol/L in females. All the items were included in the national inter-room quality assessment which was hold twice a year.

To facilitate the development of the FPHC program, the MHC established a standard data system and developed digital home files for this program. The FPHC surveillance system was set up with different permissions for different levels of staff. The MHC requires area maternal and child health hospitals to build a paper file for every couple undergoing an FPHC and input these files into the FPHC surveillance system. The information in this system was audited stepwise by the maternal and child health hospital and health administrative departments.

2.3. Statistical analysis

The database was exported from PPHCISS. Microsoft Excel 2010 was used for preliminary data analysis. Descriptive analysis, *t*-tests, and Chi-Squared tests. If $P < .05$, the difference was considered statistically significant were carried out using SPSS 25.0.

3. Results

3.1. Demographic characteristics of couples who underwent the FPHC

Totally, 182,450 (21.72%) individuals were older than 35 years, 254,456 (33.12%) individuals had an education level of junior high school or below, 551,449 (65.65%) individuals lived in rural areas, 1285 (0.16%) individuals personally suffered from defects, 257,471 (69.48%) couples planned a second or more child, 1036 (0.35%) couples delivered a baby with BDs, and 114,892 (27.36%) couples had history of adverse pregnancy outcomes among 419,971 couples who underwent the FPHC (Table 1).

3.2. Prevalence of chronic disease among couples who underwent the FPHC

Table 2 indicates that 49,421 (11.8%) females were underweight. Additionally, 200,128 (24.05%) people in total were overweight or obese, and the prevalence rate was higher in females than that in males (31.91% vs 16.31%). The total prevalence of anemia was 3.04%, and the rate was higher in females than that in males (5.53% vs 0.51%). The total proportion individuals with positive blood sugar screening results were 5.45%, and the proportion was higher in males than that in females (5.89% vs 5.01%). The total prevalence of hypertension was 1.89%, and the rate was higher in males than that in females (2.43% vs 1.35%). The total proportion of individuals with work-related pressure was 14.51%, and the rate was higher in females than that in males

Table 1

Descriptive characteristics of couples who underwent the FPHC (n, %).

Characteristics	Female (%)	Male (%)	Total (%)
Age			
<20	343 (0.08)	60 (0.01)	403 (0.05)
20~	92964 (22.14)	33170 (7.90)	126134 (15.02)
25~	165508 (39.41)	163165 (38.85)	328673 (39.13)
30~	87407 (20.81)	114875 (27.35)	202282 (24.08)
35~	73749 (17.56)	108701 (25.88)	182450 (21.72)
All	419971	419971	839942
Education			
Junior high school or below	133138 (34.68)	121318 (31.56)	254456 (33.12)
senior high school/college	226868 (59.09)	238994 (62.18)	465862 (60.63)
undergraduate or above	23942 (6.24)	24072 (6.26)	48014 (6.25)
All	383948	384384	768332
County			
urban	146992 (35.00)	141543 (33.70)	288535 (34.35)
rural	273000 (65.00)	278449 (66.30)	551449 (65.65)
All	419992	419992	839984
Personally suffered from defects			
Yes	951 (0.23)	334 (0.08)	1285 (0.16)
No	416166 (99.77)	411474 (99.92)	827640 (99.84)
All	417117	411808	828925
Planned a second child or more			
No	113097 (30.52)		
Yes	257471 (69.48)		
All	370568		
Delivered a baby with birth defects			
Yes	1036 (0.35)		
No	292557 (99.65)		
All	293593		
History of adverse pregnancy outcomes			
Yes	114892 (27.36)		
No	305100 (72.64)		
All	419992		

(15.39% vs 13.61%). The total proportion of individuals with economic pressure was 13.56%, and no significant difference was found between males and females ($P < .05$). The total proportion of individuals with social tensions was 8.05%, and the rate was higher in females than that in males (8.22% vs 7.88%). Approximately 5042 (0.20%) people in total had increased psychological pressure (including increased work-related pressure, economic pressure or social tension), and the rate was greater in males than in females (0.68% vs 0.54%). The total proportions of individuals positive for hepatitis B core antibody and HbsAg were 10.19% and 5.65%, respectively. The total proportions of individuals with high alanine transaminase or creatinine levels were 9.34% and 1.99%, and the rates for both were higher in males than that in females (12.80% vs 5.93% and 2.52% vs 1.47%, respectively). The proportion of females with an abnormal cervix was 3.35%, and the proportion of males with abnormal wrapping was 1.90%.

3.3. Descriptive lifestyle factors of couples who underwent the FPHC

The total proportion of smokers was 12.93%, and the rate was higher in males than that in females (27.70% vs 0.24%). Among the smokers, the average number of cigarettes smoked per day was 13.88 ± 5.90, and the number was higher in males than that in females (13.94 ± 6.94 vs 8.37 ± 4.24). The total proportion of individuals exposed to passive smoke was 6.98%, and the rate was higher in males than that in females (10.94% vs 3.58%). Among individuals exposed to passive smoke, the total exposure time per day was 26.30 ± 10.67 minutes, and the time was higher in males than that in females (29.84 ± 11.35 vs 17.90 ± 8.58 minutes). The total proportion of individuals who used alcohol was 7.80%, and the rate was higher in males than that in females (15.62% vs 1.07%). Among individuals who consumed alcohol, the average daily alcohol consumption (ml) was 83.18 ± 15.21, and the amount was higher in males than that in females (85.48 ± 19.39 vs 51.74 ± 13.31 ml). The total proportions of individuals who did not consume meat, eggs and milk or vegetables were 0.47% and 0.10%, respectively. The total proportion of individuals who consumed raw meat was 0.04%, and the rate was higher in males than that in females (0.06% vs 0.04%). The total proportion of individuals with exposure to environmental risk factors (radiation, paint, heavy metals including lead and mercury, and pesticides) was 1.30%, and the rate was higher in males than that in females (1.46% vs 1.15%) (Table 3).

3.4. Analysis of total risk factors

Among the 25 factors in Tables 1–3, with the exception of basic information including the county and planning a second or additional child, the other 23 factors were classified as risk factors. Totally, 807,712 females reported risk factors, with the

Table 2

Prevalence of chronic disease in couples who underwent the FPHC.

Chronic disease	Female (%)	Male (%)	Total (%)	X^2	*P*
BMI					
Underweight	49421 (11.80)	14883 (3.60)	64304 (7.73)		
Overweight and obese	68320 (16.31)	131808 (31.91)	200128 (24.05)	40792.62	.00
normal	301222 (71.90)	266360 (64.49)	567582 (68.22)		
all	418963	413051	832014		
Anemia					
yes	23131 (5.53)	2109 (0.51)	25240 (3.04)	83007.01	.00
no	395076 (94.47)	409761 (99.49)	804837 (96.96)		
all	418207	411870	830077		
Blood sugar					
positive screening	20944 (5.01)	24251 (5.89)	45195 (5.45)	599.37	.00
normal	397135 (94.99)	387619 (94.11)	784754 (94.55)		
all	418079	411870	829949		
hypertension					
yes	5672 (1.35)	10049 (2.43)	15721 (1.89)		
no	413106 (98.65)	402830 (97.57)	815936 (98.11)	1306.27	.00
all	418778	412879	831657		
Work-related pressure					
slight or greater	64216 (15.39)	56065 (13.61)	120281 (14.51)		
none	352984 (84.61)	355732 (86.39)	708716 (85.49)	527.83	.00
all	417200	411797	828997		
economic pressure					
slight or greater	56522 (13.55)	55858 (13.57)	112380 (13.56)		
none	360544 (86.45)	355740 (86.43)	716284 (86.44)	0.06	.80
all	417066	411598	828664		
social tension					
slight or greater	34279 (8.22)	32432 (7.88)	66711 (8.05)		
none	382920 (91.78)	379291 (92.12)	762211 (91.95)	32.24	.00
all	417199	411723	828922		
Hepatitis B core antibody					
positive	42951 (10.27)	41641 (10.09)	84592 (10.19)		
normal	375074 (89.73)	370879 (89.91)	745953 (89.81)	7.39	.00
all	418025	412520	830545		
HbsAg					
positive	21045 (5.03)	25890 (6.28)	46935 (5.65)		
normal	397062 (94.97)	386649 (93.72)	783711 (94.35)	601.197	.00
all	418107	412539	830646		
Alanine transaminase					
high	24809 (5.93)	52830 (12.80)	77639 (9.34)		
normal	393424 (94.07)	359851 (87.20)	753275 (90.66)	11572.517	.00
all	418233	412681	830914		
Creatinine					
high	6144 (1.47)	10379 (2.52)	16523 (1.99)		
normal	412089 (98.53)	402302 (97.48)	814391 (98.01)	1166.04	.00
all	418233	412681	830914		
Abnormal cervix					
yes	14012 (3.35)				
no	403950 (96.65)				
all	417962				
Abnormal wrapping					
yes	7832 (1.90)				
no	405091 (98.10)				
all	412923				

mean number of 1.92 per female, and 911,350 risk factors were reported by males, with the mean number of 2.17 per male.

4. Discussion

In our study, 257,471 (69.48%) couples planned a second or additional child, similar to the study of Wang et al that the ideal number of children among the urban working women in China was 2.03 ± 0.35.[9] In recent years, the Chinese government has been aware of problems associated with a low population growth rate and begun to implement a two-child policy.[10] In developing countries, rural fertility exceeds urban fertility at an even greater rate.[11] Our result showed that 551,449 (65.65%) couples lived in rural areas, and 254,456 (33.12%) couples had an education

Table 3

Descriptive lifestyle factors of couples who underwent a pre-pregnancy health check.

lifestyle	Female (%)	Male (%)	Total (%)	X^2/t	*P*
smoking					
yes	1007 (0.24)	99317 (27.70)	100324 (12.93)	129100.046	.00
no	416158 (99.76)	259247 (72.30)	675405 (87.07)		
all	417165	358564	775729		
number of cigarettes smoked per day	8.37±4.24	13.94±6.94	13.88±5.90	-25.529	.00
number of individuals exposed to passive smoke					
yes	14957 (3.58)	39198 (10.94)	54155 (6.98)		
no	402267 (96.42)	319235 (89.06)	721502 (93.02)	16042.412	.00
all	417224	358433	775657		
passive smoke exposure time per day (minutes)	17.90±8.58	29.84±11.35	26.30±10.67	-14.418	.000
alcohol					
yes	4469 (1.07)	56000 (15.62)	60469 (7.80)		
no	412715 (98.93)	302543 (84.38)	715258 (92.20)	567754.543	.00
all	417184	358543	775727		
Average daily alcohol consumption (ml)	51.74±13.31	85.48±19.39	83.18±15.21	-7.689	.000
Consumption of meat, eggs and milk					
yes	415638 (99.67)	356029 (99.38)	771667 (99.53)	336.361	.00
no	1397 (0.33)	2220 (0.62)	3617 (0.47)		
all	417035	358249	775284		
No consumption of vegetables					
yes	380 (0.09)	423 (0.12)	803 (0.10)		
no	416908 (99.91)	357922 (99.88)	774830 (99.90)	13.568	.00
all	417288	358345	775633		
Consumption of raw meat					
yes	146 (0.04)	202 (0.06)	348 (0.04)		
no	416964 (99.96)	358008 (99.94)	774972 (99.96)	19.651	.00
all	417110	358210	775320		
exposure to risk factors (radiation, paint, heavy metals including lead and mercury, and pesticides)					
yes	4808 (1.15)	5197 (1.46)	10005 (1.30)		
no	411614 (98.85)	350752 (98.54)	762366 (98.70)	140.032	.00
all	416422	355949	772371		

level of junior high school or below. Perhaps rural couples with a lower education level have fewer requirements with regard to raising a child and have more traditional ideas about raising sons to support them during older age. Therefore, more than half of couples planned to have a second child in Hunan, China.

A comparison between the data from Hunan province and the whole China showed that the proportions of females with a history of adverse pregnancy outcomes (27.36%) and older than 35 years old (17.56%) were higher than the values in China (21.18% and 16.5%, respectively)[8,12] (Fig. 1). Donghua Xie et al found that older age was one of the major determinants of BDs.[13] As reported, advanced maternal age (35–40 years old) is associated with congenital heart defects in infants (OR = 1.12, 95% CI: 1.03–1.22).[14] In addition, the rates of adverse pregnancy outcomes were higher among women with a history of stillbirth due to preeclampsia (3.3% vs 0.9%, $P = .002$), preterm birth (8.5% vs 3.9%, $P = .004$), small-for-gestational-age children (7.8% vs 2.2%, $P < .001$) and stillbirth (2.7% vs 0.3%, $P < .001$).[15] Therefore, according to a comparison of Figures 1 and 2 females older than 35 years and those with a

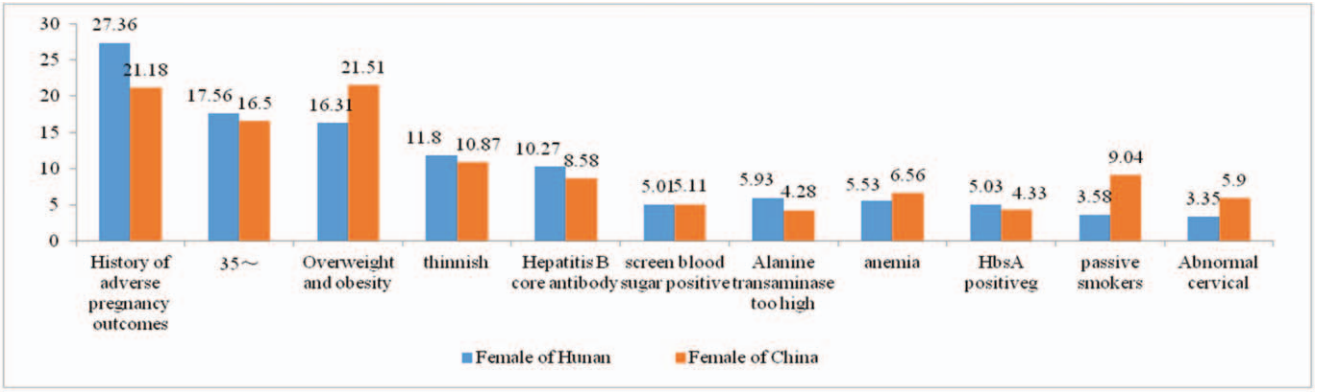

Figure 1. The proportions of different risk factors in pre-pregnancy female of Hunan and China (%).

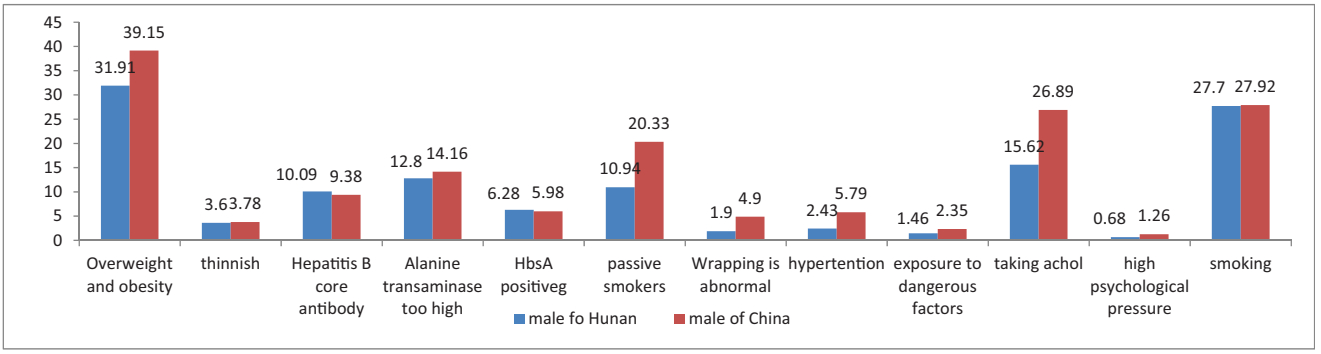

Figure 2. The proportions of different risk factors in pre-pregnancy male of Hunan and China (%).

history of adverse pregnancy outcomes are the key focus of intervention.

Overall, males had more risk factors than females (2.17 per male vs 1.92 per female), similar to the results of Wang WH et al, which demonstrate that the mean numbers of risk factors were 2.41 per male and 1.85 per female in Shanxi province.[16] Firstly, the prevalence of hypertension was 1.89%, and the rate was higher in males than that in females (2.43% vs 1.35%). Generally, the prevalence is higher among older people, and a survey by Wu Xiaoyan et al showed that the prevalence of hypertension was 35.3% in males and 32.9% in females with the total mean age of 50.0 ± 11.6.[17] The reason for this difference between males and females is still unclear. Perhaps the distribution of the gene with regards to susceptibility to hypertension is different in females and males.

Secondly, the proportion of individuals with increased psychological pressure (including increased work-related pressure, economic pressure or social tensions) was larger in males than that in females (0.68% vs 0.54%), similar to a study in Hubei province.[18] One reason for this diversity is that more males have high-risk occupations such as police officers, aviators, coal workers, and construction workers.[19,20] Thirdly, the proportion of individuals with high alanine transaminase or creatinine levels was larger among males than that among females (12.80% vs 5.93% and 2.52% vs 1.47%, respectively). Perhaps more males consumed alcohol which may lead to liver damage.[21] A study by Babak Bagheri et al showed that male sex was a risk factor for elevated serum creatinine levels.[22] Fourthly, the proportions of smokers, individuals exposed to passive smoke, and individuals who consumed alcohol were higher among males than females (27.70% vs 0.24%, 10.94% vs 3.58%, and 15.62% vs 1.07%), and these are social determinants of chronic disease.[23] A study by Zwink N et al showed that parental risk factors such as smoking before conception significantly increased the risk for malformations.[24] Finally, the proportion of individuals exposed to environmental risk factors (radiation, paint, heavy metals including lead and mercury, and pesticides) was higher in males than that in females (1.46% vs 1.15%), which can be explained by the fact that more males work on jobs related to these factors[20,25]

Additionally, some risk factors were higher in females than males. Firstly, the prevalence of anemia was higher in females than males (5.53% vs 0.51%), which is similar to a study by Marsella M et al that adopted a cross-sectional evaluation.[26] Anemia is caused in most females through the loss of iron during pregnancy and menstruation. Secondly, the proportions of individuals with work-related pressure and social tensions were both higher among females than males (15.39% vs 13.61%, 8.22% vs 7.88%, respectively). Currently a growing number of women perform jobs similar to men, and in the meanwhile have to take more family responsibilities, such as pregnancy, caring for children, and housework.

In summary, this study illustrates the risk factors for pre-pregnancy couples and compares the differences in males and that in females through a cross-sectional analysis of the FPHC system of Hunan, China, in 2019. However, there exist some limitations. Firstly, the FPHC system only includes designated examination results. When the blood sugar screening was positive in males or females, the diagnosis of diabetes was not recorded. Therefore, the diagnoses of some diseases could not be analyzed. Secondly, the pregnancy outcome was input according to a follow-up strategy, which was not completely accurate and prevented analysis of the association of risk factors with BDs. In the following year, we will combine the BD monitoring system with the FPHC system to ensure the accuracy of pregnancy outcomes without manual recording.

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