Epidemiological Characteristics of Rubella in Beijing Haidian District of China, 2005 - 2020

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Abstract

Background: This study aimed to investigate the epidemiological characteristics of rubella in Beijing Haidian District of China, from 2005 to 2020, providing scientific basis for controlling the prevalence of rubella and the congenital rubella syndrome (CRS).

Methods: Data were collected via the legal infectious disease report cards from medical institutions in Beijing Haidian District during 2005 to 2020. The descriptive epidemiological methods plus statistic analysis were used to analyze the distribution of rubella in terms of population, time and region.

Results: In total, there were 994 cases of rubella in Beijing Haidian District, with an average annual incidence of 1.81/100,000 population. The majority of patients were at the age from 15 to 29 years old, accounting for 63.4%. And the sex ratio of male-to-female was 1.45:1. The rubella had a feature of spatial aggregation and appeared in all the regions in Haidian District. In 2007, Haidian District was hitted by rubella with the highest incidence up to 8.37/100,000, in the past 16 years. The peak incident of rubella was in May of that year, accounting for 74.8%. The majority of rubella patients were students and employees (70.1%) mainly due to the gathering. According to Joinpoint regression model, rubella would still exist in the next three years with 2-5 new cases per year.

Conclusions: The number of rubella in Haidian District showed a downshift trend from 2008 to 2014 and then a sporadic distribution till 2020. Yet this disease was not completely eliminated, it is quite impending to improve the awareness of rubella and their health literacy mentally and physically in the whole population by means of the policy issuing from government.

Introduction

Rubella, known as German measles or three-day measles, is an acute respiratory contagious disease caused by RNA virus (genus Rubivirus). It is usually a self-limited illness along with mild consequences, and difficult to discover in adults. What makes it terrible is that contagion may result in the cluster of spread before the onset of typical symptoms. Humans are the only known natural host of rubella as yet. The infected can spread through person-to-person contact. Pregnant women who got infection may bring devastating effects to their children, ranging from abortions to infants with congenital rubella syndrome (CRS), including visual or hearing impairment, heart disease, and so on [1]. Especially in the first trimester [2], the virus could pass through the placental barrier with dominant infection or not. Rubella occurs through all the year, exhibiting a fluctuating curve with high incidences in low-temperature weather. It could be epidemic widely every 6 to 9 years, even an outbreak.

Rubella was a severely contagious disease, spreading in a short time among the susceptible population. In the 1960s, there was a large-scale epidemic in the USA (United States of America). In order to control rubella and eliminate CRS, the USA began to implement combined rubella vaccine and got the favorable results [3]. In 2005, the World Health Organization announced a milestone event that the Americas region

had eliminated rubella and CRS [4]. Immunization is the optimum way to prevent rubella currently. The European Vaccine Action Plan 2015–2020 (EVAP) proposed that 95% inoculation rate could protect babies and the handicapped who cannot be vaccinated, ultimately to improve the health of the whole population. However, rubella is not completely wiped out in the other part of the world. Over 100,000 infants were born with CRS every year, and up to 80% of those from Africa and Asia [1]. Busy and crowding areas were still under higher risk of rubella [5]. Rubella is still an urgently public health issue to human. Effective vaccine did not fully cover the whole world, especially in developing countries and areas. Moreover, it is noteworthy of the underlying risk from global travel and mobility of population.

China has formally introduced the rubella-containing vaccine (RCV) into the Expanded Immunization Program (EPI) since 2008 [6], while rubella cases were still occurring in the country. Even in 2018–2019, the morbidity of rubella rose in China [7, 8]. Beijing is a prosperous metropolis around the world, attracting the domestic and external population. The annual incidence of rubella manisfested that Beijing was still under the menace of RV in the other districts of adjacent to Haidian District, such as Xicheng District[9] (3.25/100,000) from 2003 to 2008, Shunyi District [10] (14.82/100,000) in 2007 and (15.08/100,000) in 2008, and Changping District[11] (10.465/100,000) from 2007 to 2011. This study aimed to grasp the currently epidemic status of rubella in Beijing Haidian District from 2005 to 2020, providing the feedback on the prevention and control of rubella scientifically and effectively in the future.

Methods

Source of information

All the cases data were gathered by the legal infectious disease report cards from medical institutions in Beijing Haidian District during 2005 to 2020. Demographic data, including total population and regional distribution data, were from the Beijing Regional Statistical Annual, which belonged to the Beijing Municipal Bureau of Statistics. All the cases lived in Beijing Haidian District currently.

Data inclusion

The diagnosis of cases were verified by contagious specialists according to the serum rubella antibodies or the isolation of positive rubella virus in accordance with the Rubella Diagnostic Standards from the Ministry of Health of China. All the medical staffs professionally mastered the diagnostic standard and reporting procedures. All the confirmed cases in this study met the statutory infectious disease report. According to the age distribution of cases, there were four groups (> 15, 15–29, 30–49, > 49 years old). Since the incidence of rubella showed a sporadic situation since 2013, all the cases were divided into two timeframes including 2005–2012 and 2013–2020.

Predictive model for Rubella

The Joinpoint regression program (JRP) was used to fit the time-series of the number of new cases of rubella in Haidian District. As required, the value of the incidence of “0” was replaced by “0.5”. The

Kolmogorov-Smirnov (K-S) corrected by Lilliefors was used to the test of normality of dependent variable.

Statistical analysis

The Microsoft Excel 2016 and SPSS 20.0 were used to sort and analyze the collected data. The descriptive epidemiological methods were used for the statistical description and analysis of rubella cases. The Chi-squared test was used to assess the difference in categorical variables. A two-sided test and $P < 0.05$ were the criteria for statistical significance.

Results

The epidemic situation of rubella

From 2005 to 2020, a total of 994 cases of rubella were reported in Beijing Haidian District with an average annual incidence of 1.81/100,000. In 2007, the rubella incidence rate was up to 8.37/100,000, which was the highest incidence from 2005 to 2020 and up to 4.6 times higher than the average incidence. The rubella in Haidian District seemed gradually in the optimism since 2013. During 2005 to 2012, the average incidence was 3.26/100,000, and from then on it reduced to 0.47/100,000 in the next eight years. In 2020, the incidence was down to 0.14/100,000. In addition, there was zero death reported from cases, as shown in Fig.1.

Seasonality analysis

In the line chart from Fig2, the incidence of rubella showed an obviously seasonality fluctuation in Haidian District. The highest morbidity arose in May and reach the lowest in September. Rubella prevalence seemed to accompany along with spring weather (the averaged temperature in Haidian District: -2 to 8 ℃). Summing up the cases in peak months (March to May), there was a cumulative number of 577 cases, accounted for 58.1% of the total patients.

Population distribution analysis

There were 448 local patients and 546 non-native patients, accounting for 45.1% and 54.9% respectively in the past 16 years. The incidence of nonlocal patients was more than the locals with the statistically significant different ($\chi^2 = 9.662$, $P = 0.002$). The youngest baby of onset was only 27 days old, and the oldest was 90 years old. Over 1/2 patients (63.4%) were at the age of 15 to 29 years old. The male-to-female ratio of cases was 1.45:1 (588/406) among the patients. There was a significant difference between the morbidity of gender ($\chi^2 = 33.324$, $P < 0.000$). There were 299 female patients in childbearing age (15 - 49 years old), accounting for 30.1%. The high-risk incidence of crowd of rubella were students and employees, accounting for 29.9% and 40.2% relatively. Besides, male had a higher occurrence in these two groups as shown in Fig.3, Fig.4 and Table 1.

Local distribution characteristics

For ensuring the effective administration, the Haidian District was divided into 29 streets according to the cultural features and geographical location. While there was a significant regional difference the incidence (χ^2 = 750.000, P < 0.000), it is obvious that rubella has a regional clustering character. Shangdi Street had the largest number of cases, with the regional morbidity of 9.2/100,000. And the surrounding streets had relatively high incidences, such as Malianwa Street (1.92/100,000), Xibeiwang Street (1.54/100,000) and Qinglongqiao Street (1.34/100,000). The top ten streets of rubella patients were the Shangdi Street, Xueyuan Road, Malianwa Street, Wanshou Road Street, Sijiqing Street, Xibeiwang Street, Qinghe Street, Zhongguancun Street, Qinglongqiao Street, Haidian Street, as shown in Fig. 5 and Table 2.

The joinpoint regression analysis of the rubella

The annual rubella cases obeyed normality distribution (Z = 0.877, P = 0.426). The mean squared errors (MSEs) were 5.04 and 3.93, respectively, after the calculation by model 1 & 2 in JPR. The model 2 was chosen to estimate the critical point of epidemic trend. As it shown in Fig.6, there were two segment point which were 2007 and 2017. The fitting regression equation is as follow: $E[y_i|x_i]=EXP(-2401.056874+1.197275*x_i-1.531075*(x_i-2007)^+ +0.841992*(x_i-2017)^+$. [If $(x_i- \tau_k) > 0$, then $(x_i-\tau_k)^+ = (x_i-\tau_k)$, otherwise $(x_i-\tau_k)^+ = 0$, y_i is the number of patients, x_i is the year, τ_k is the change point]. According to the Joinpoint regression model, rubella wasn't eradicated in Beijing Haidian District, and in the next three years there would be 2, 3 and 5 new cases, respectively. As shown in Fig7, the female in Haidian District would have a higher potential risk in suffering rubella than male.

Discussion

The prevalence of rubella in different regions would come out with a variety of consequences[12]. This study found that the incidence of rubella in Beijing Haidian District was 1.81/100,000, from 2005 to 2020. It is lower than that of the other District in Beijing[9–11], which might be related with its booming economy and higher living standards. However, rubella didn't eliminate in Haidian District. Rubella has general population susceptibility, the free rubella vaccine program aim to the migrant workers has a low inoculation rate, which is accordance with the result. More than half of patients (54.9%) are external population, as the research showed. In terms of occupation, students and employees had the higher morbidity. Overcrowding population may bring a higher risk to virus transmission, and result in an adverse incidence of rubella further. Therefore, it is suggested that strengthening the monitoring of health issues, can prevent the outbreak of this disease effectively in public places, especially in high risk population like the intense crowds and the migrant.

With the gradual development in the living and sanitary conditions, rubella has been well controlled through vaccine immunization. As the literature described, when the rubella outbreaks, diverse RCVs could be able to provide 90% – 100% effective protection[13]. According to the WHO, large-scale rubella vaccination has helped lots of countries significantly reduce or virtually eliminate rubella and CRS[12]. However, there are still some countries and regions, including developed countries, being threatened by

the spread and epidemic of rubella, and even underlying the tendency to outbreak[12, 14]. In September 2006, Beijing, as the first city in China, started to introduce the trivalent measles, mumps and rubella vaccine (MMR) into type I vaccine, which was given to target children aged 1.5 and 6 years free of charge[10]. With the effective penetration of the EPI, the dynamics of virus transmission have changed, main susceptible group of rubella was rather the higher age group, than the preschool children. This trend has also been observed in other Chinese cities, such as the Fengxian District of Shanghai[15] and the Zhoangshan city of Guangdong [16]. This study also manifested the same trend, people aged 15 to 29 had higher incidence.

What deserves more attention is that pregnant women with viral infection can often cause death or CRS to the fetus[17]. Reportedly, there are still CRS kids born without a healthy body nowadays[18]. As researches suggested that rubella infection rates are higher in urban women than in rural women, in addition, childbearing age women have a higher risk of rubella infection[19, 20]. Some European countries, such as Finland, Iceland, Norway, and Sweden, have implemented rubella vaccination unremittingly, which has successfully blocked its transmission and eventually eliminated CRS. While, the coverage of rubella vaccine in developing countries is not comprehensive, which will put them under the threat of rubella and even an aggravate burden to society[21]. One of the studies found that vaccination of school girls not only could reduce cases of rubella, but also effectively lower the incidence of CRS[22]. Other research also suggested that the majority of CRS heart diseases can be avoided through vaccinating adults and kids [4]. In this research, the female in Beijing Haidian District seemingly would have a higher potential threat by rubella. Screening and protecting of women in reproductive age is the key to prevent CRS, and it is also a response to the national policy of eugenic. Since more and more travelling and migration, rubella has the possibility of danger been imported into areas where rubella is nonexistent, leading to outbreaks and the reappearance of transmission. Meanwhile, a further consideration is the impact of the current COVID-19 pandemic on vaccinations. The preliminary data registered in the USA indicate that a general decline in global immunization coverage is expected [23]. There are still some vaccination gap in the population [7–8]. Given that the population's behavioral patterns, low awareness of rubella and some individual reasons for vaccine hesitant, the primary challenge is to fill the gap by encouraging appropriate newborns and susceptible population to go to hospital to receive a serum antibody test and vaccinations, finally improve the health of the population. The further public strategies of rubella should keep abreast with the situation to reduce the incidence of rubella and CRS effectively.

Conclusion And Recommendations

In conclusion, the incidence of rubella in Beijing Haidian District is under control, while is not completely eliminated. While there were more male rubella patients, it is equally important that the female might under the latent higher risk. According to the current status, it is wise to confirm the susceptible group and implement the vaccine coverage. There is no doubt that improving and perfecting the sanitation system to control and eliminate the rubella should be stepped up continuously, which would bring us a healthier country.

Abbreviations

Rubella virus, RV, Congenital rubella syndrome, CRS, Rubella-containing vaccines, RCVs, the European Vaccine Action Plan 2015-2020, EVAP.

Declarations

Ethical approval and consent to participate

According to National Health Commission of the People's Republic of China, the data involved in this study did not include any data of patients' personal information, including name, identifying information, exact address, telephone number, etc. This study mainly focused on aggregating the available data, so consent to participate and ethics approval are unnecessary.

Consent for publication

Not applicable.

Availability of data and materials

Data of the study was not publicly available, the datasets used and analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

SY and XP interpreted the data and wrote the manuscript. FW, CZ and LZ collected and collated data. JY and HL revised the work. The study on which this paper was conceived and designed by ZW and WZ. All authors have commented on drafts of the paper and approved this submitted version.

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Not applicable.

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Tables

Table 1 General demographic characteristics of rubella cases in Beijing Haidian District from 2005 to 2020

characteristic	Year		*n*	%
	2005-2012	2013-2020		
Gender				
Male	508	80	588	59.1
Female	352	54	406	40.8
Native place				
Local	377	71	448	45.1
Non-native	483	63	546	54.9
Age (year)				
<15	195	30	225	22.6
15-29	556	85	634	63.4
30-49	101	27	128	12.8
>49	8	2	10	1.2
Occupation				
Children living at home	59	22	81	8.1
Kindergarten children	51	5	56	5.6
Students	266	32	298	29.9
Employee	341	59	400	40.2
Unemployed	87	16	103	10.3
Unknown	56	0	56	5.6
Total	860	134	994	100.0

Table 2 Incidence distribution of rubella in streets of Beijing Haidian District from 2005 to 2020

Street	Year		*n*	%	Morbidity (/100,000)
	2005-2012	2013-2020			
Wanshou Road street	52	7	59	5.94	1.72
Yongding Road street	23	2	25	2.52	0.73
Yangfangdian street	16	6	22	2.21	0.64
Ganjiakou street	15	3	18	1.81	0.52
Balizhuang street	25	4	29	2.92	0.84
Zizhuyuan street	37	5	42	4.23	1.22
Beixiaguan street	32	6	38	3.82	1.11
Beitaipingzhuang street	28	4	32	3.22	0.93
Xueyuan Road sreet	62	8	70	7.04	2.04
Zhongguancun street	45	5	50	5.03	1.46
Haidian street	42	3	45	4.53	1.31
Qinglong Bridge street	38	8	46	4.63	1.34
Qinghuayuan street	26	2	28	2.82	0.82
Yanyuan street	12	3	15	1.51	0.44
Xiangshan street	13	1	14	1.41	0.41
Qinghe street	36	6	42	4.23	1.22
Huayuan Road street	22	5	27	2.72	0.79
Xisanqi street	20	2	22	2.21	0.64
Malianwa street	60	6	66	6.64	1.92
Tiancun Road street	24	7	31	3.22	0.90
Shangdi street	76	18	94	9.46	2.74
Wanliu area	5	3	8	0.80	0.23
Dongsheng area	6	0	6	0.60	0.17
Shuguang street	18	5	23	2.31	0.67
Wenquan town	10	1	11	1.11	0.32
Sijiqing town	51	4	55	5.53	1.60
Xibeiwang town	47	6	53	5.33	1.54

Sujiatuo town	6	2	8	0.80	0.23
Shangzhuang town	6	2	8	0.80	0.23
Unknwon	6	0	6	0.60	0.17
Total	860	134	994	100.00	1.81

Figures

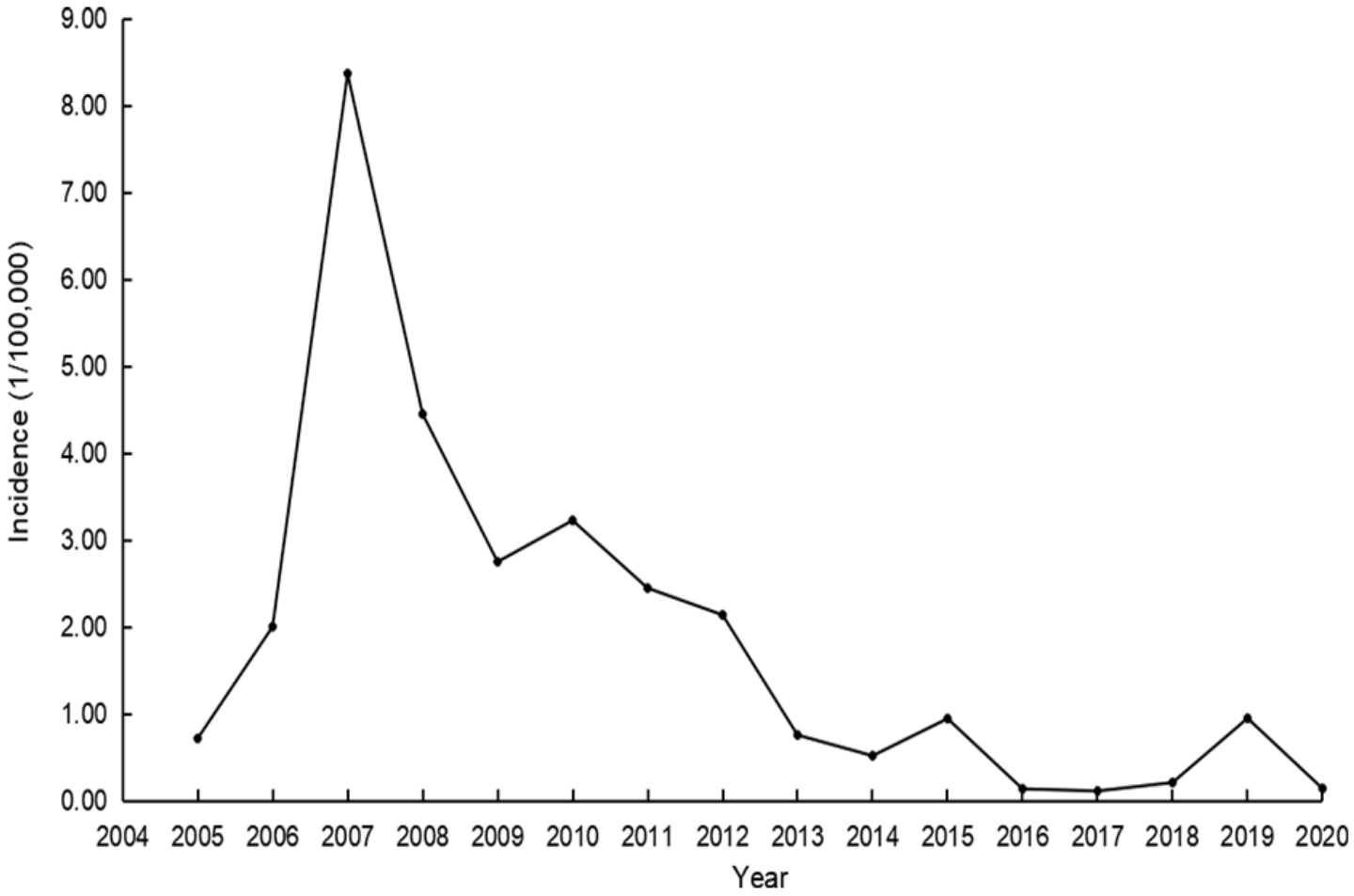

Figure 1

Distribution of incidence of rubella in Beijing Haidian District from 2005 to 2020

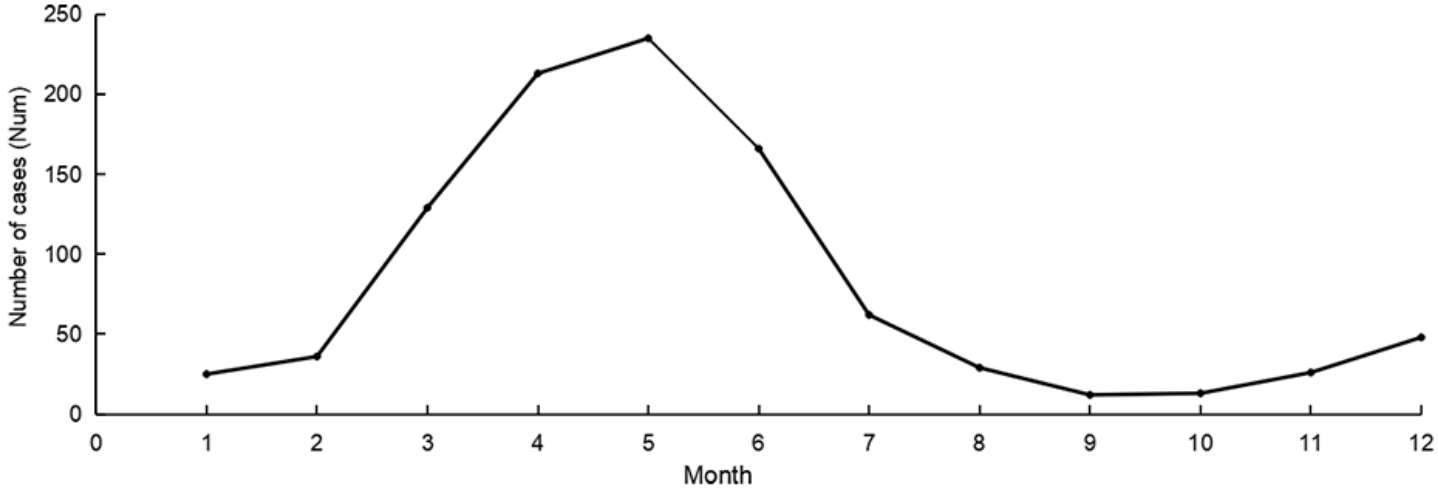

Figure 2

Distribution of incidence of rubella in Beijing Haidian District from 2005 to 2020

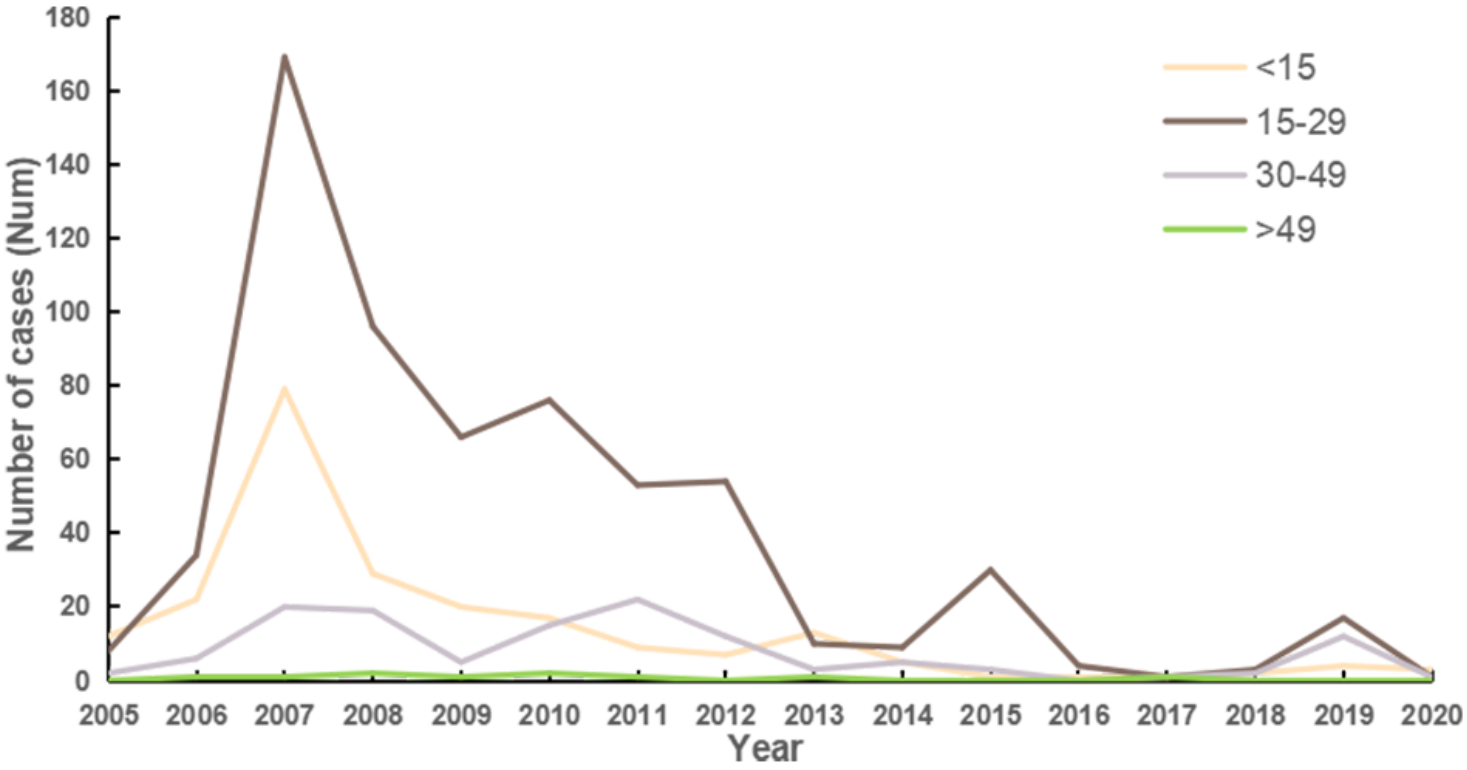

Figure 3

Distribution of incidence of rubella sorted by age in Beijing Haidian District from 2005 to 2020

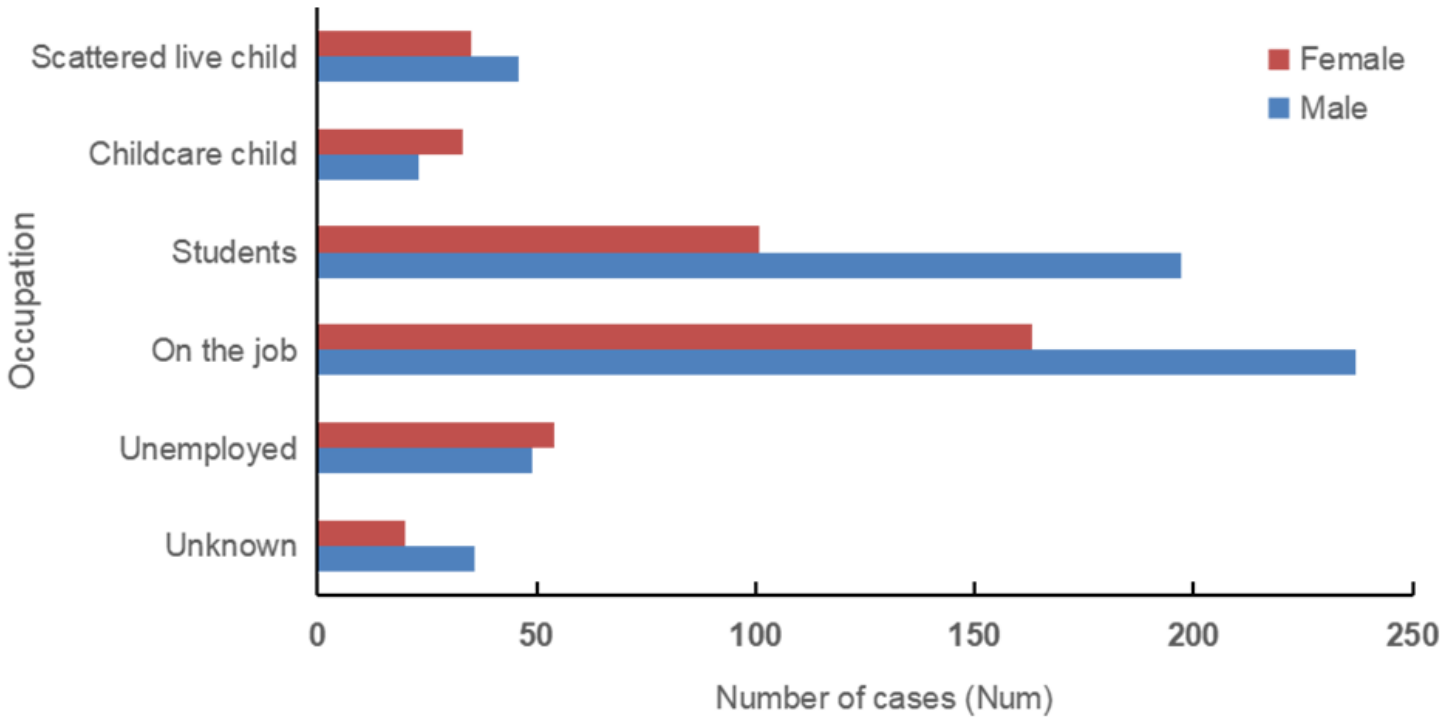

Figure 4

Distribution of incidence of rubella sort by occupation between gender in Beijing Haidian District from 2005 to 2020

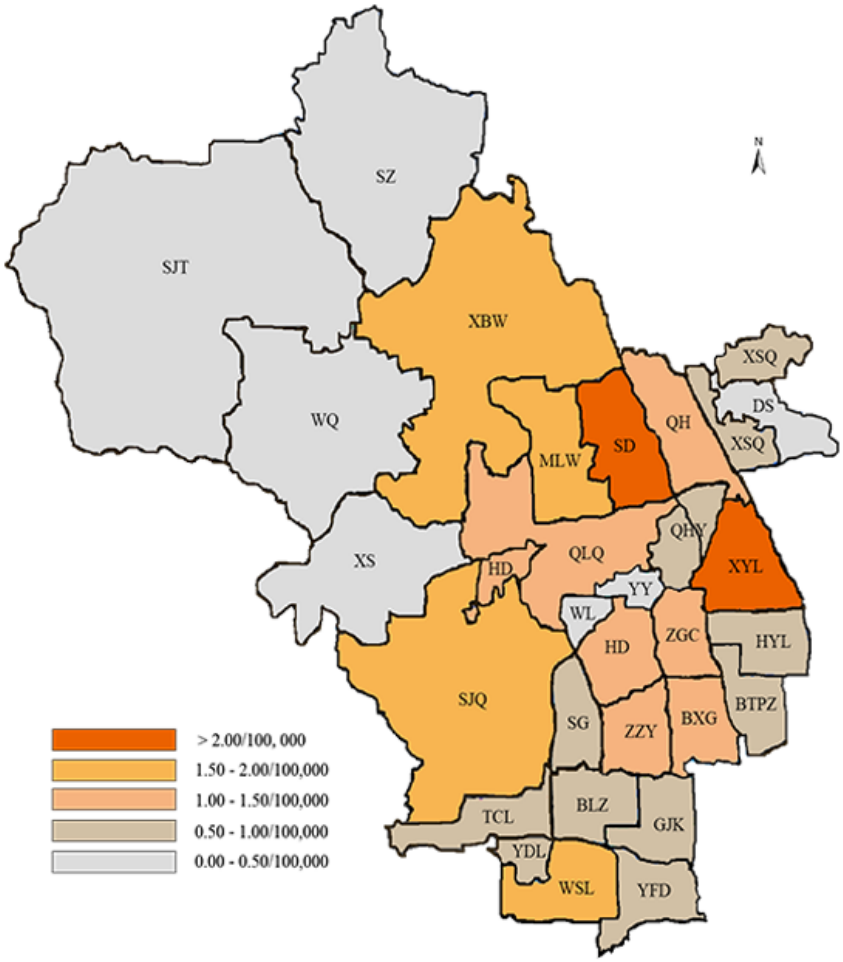

Figure 5

Incidence distribution of rubella in streets of Beijing Haidian district from 2005 to 2020 Haidian District: Wanshou Road (WSR), Yongding Road (YDR), Yangfangdian (YFD), Ganjiakou (GJK), Balizhuang (BLZ), Zizhuyuan (ZZY), Beixiaguan (BXG), Beitaipingzhuang (BTPZ), Xueyuan Road (XYR), Zhongguancun(ZGC), Haidian (HD), Qinglongqiao (QLQ), Qinghuayuan (QHY), Yanyuan (YY), Xiangshan (XS), Qinghe (QH), Huayuan Road (HYR), Xisanqi (XSQ), Malianwa (MLW), Tiancun Road (TCR), Shuguang (SG), Shangdi (SD), Wanliu (WL), Dongsheng (DS), Wenquan (WQ), Sijiqing (SJQ), Xibeiwang (XBW), Sujiatuo (SJT), Shangzhuang (SZ). Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

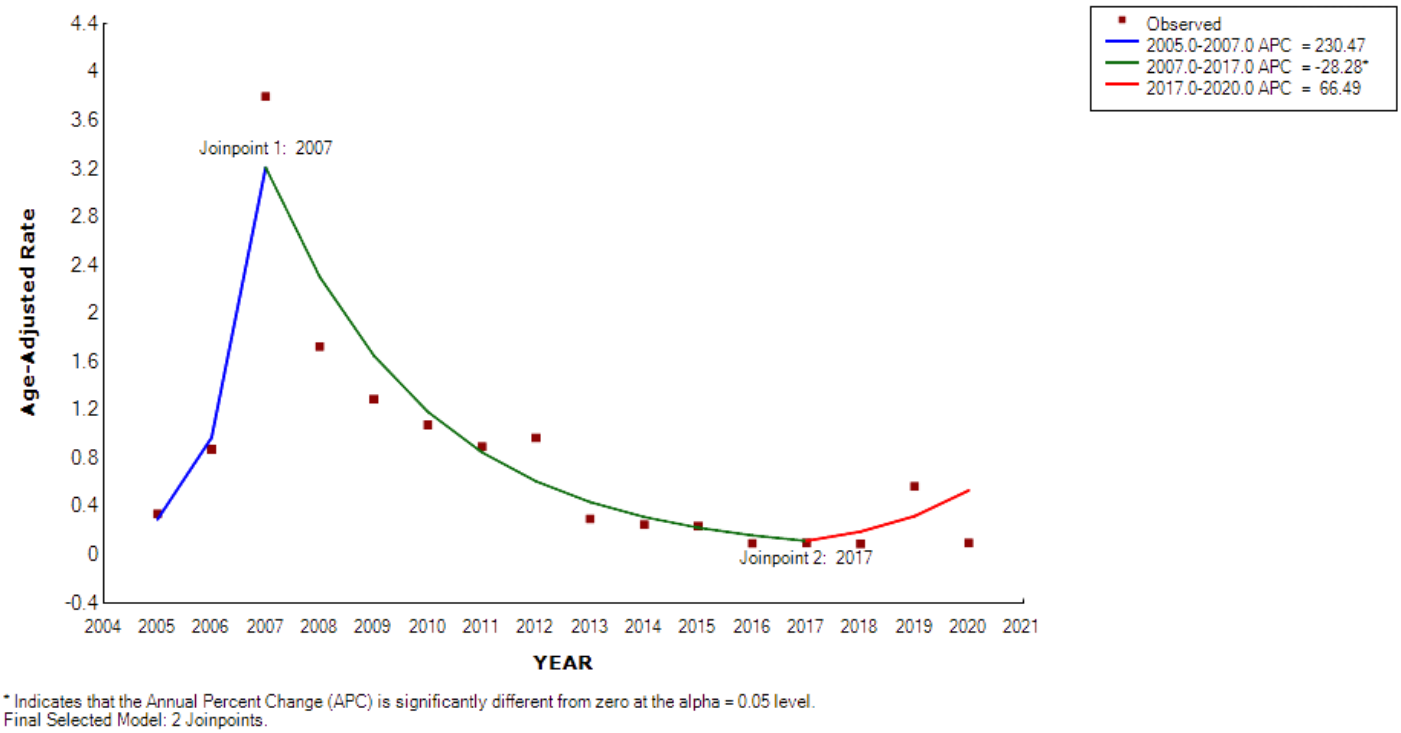

Figure 6

Joinpoint trend change of annual incident Beijing Haidian district from 2005 to 2020

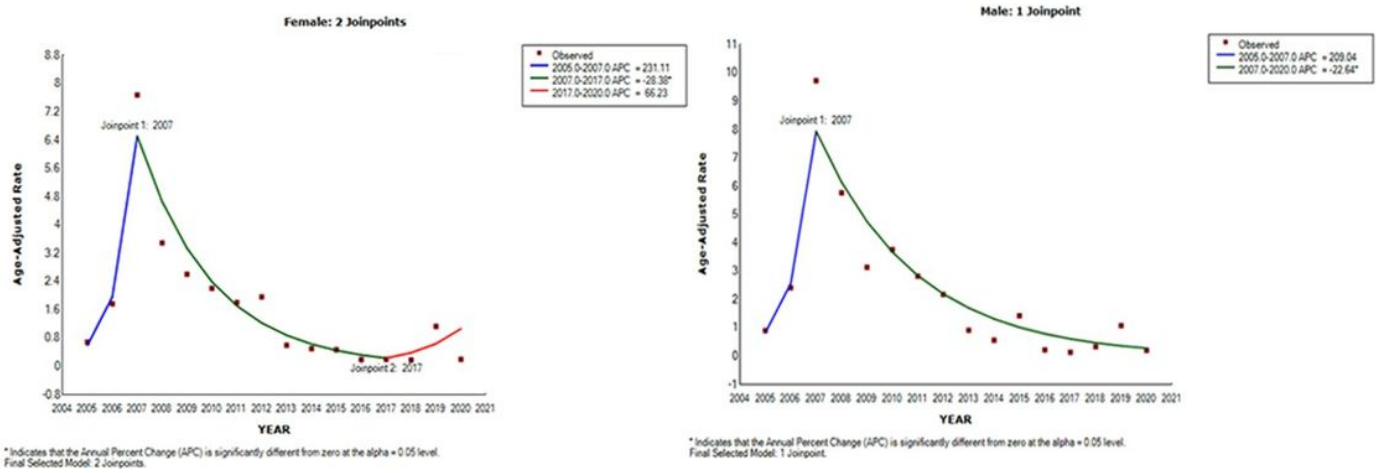

Figure 7

Joinpoint trend change of rubella between different sex in Beijing Haidian District from 2005 to 2020