Proceedings of the 4th International Conference on Biological Engineering and Medical Science
DOI: 10.54254/2753-8818/72/2024.18870

The spread and prevention of varicella in China

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Abstract. The varicella-zoster virus (VZV), a common infectious disease in children, is the cause of varicella, a highly contagious illness. The infectious disease is more prevalent in youngsters, although it affects adults, pregnant women, and people with impaired immune systems more severely. The illness frequently manifests as itchy blisters and scabs, and it may start with a low-grade temperature and pain. Understanding the infectious mechanisms that contribute to varicella and the fundamental prevention actions is therefore essential. This essay will study the relationship between Varicella infectivity and temperature in meteorological factors as well as gender and age in personal factors through the way of paper review, and propose that the most common preventive measure is the way of vaccination. Finally, the result of the study is that the infection is indeed related to the change in temperature, and the temperature change in different regions makes the infection situation of Varicella at different temperatures different. In addition, Varicella infection is particularly high in infants and young children with low immunity, and the infection rate is slightly higher in men than in women.

Keywords: Varicella, China, Factors affecting infectivity, Vaccination.

1. Introduction

Varicella (also known as Varicella) is an acute infectious disease caused by varicella-zoster virus (VZV) infection, whose symptoms are discomfort, fever, and itchy water herpes throughout the body [1]. It is spread through atomized droplets in the air as well as person-to-person skin-to-skin contact and is highly contagious, with up to 90 percent of patients affected after exposure [1]. Varicella is a widespread childhood infection that is usually self-limited and follows a mathematical model of susceptibility - Infection - recovery (SIR), thus providing lifelong immunity to those who have recovered [2]. Nevertheless, it can cause serious complications and increased mortality in certain high-risk groups, such as pregnant women and infants [3]. In China, the incidence and outbreak of Varicella have risen significantly in recent years, with an incidence of 70.14 per 100,000 people in 2019 [4]. Therefore, it is of great significance to understand the transmission route, vaccination strategy, and preventive measures for preventing and controlling Varicella outbreaks. This essay will use the way of thesis review to discuss the meteorological factors and personal factors that affect the transmission of Varicella, and measures to prevent Varicella infection—vaccination.

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2. Influence Factors

2.1. Temperature affects the transmission rate of Varicella

Varicella transmission may be influenced by a variety of circumstances, including exposure to personal activities and various environmental habitats. Numerous investigations have indicated a potential correlation between the incidence of Varicella infection and climatic variables, including air pollution and relative temperature [4]. While one study found a slight correlation between Varicella and air pollution, another study found a correlation between Varicella and relative temperature [4]. First, the study examined how temperature affects Varicella infectivity in a few Chinese towns. The exposure-response relationship between Guangdong's varicella and temperature is depicted in Figure 1. An approximate S-shape is shown by the image estimation, which indicates a nonlinear link between temperature and Varicella.

From this discovery, the scientists found that the relative risk of chickenpox peaked at 20.8°C, with reference temperatures distributed at the 99th percentile [4]. Meanwhile, the overall effect of the temperature variable on Varicella in Lu' a City, Shanxi Province in 21 days is shown in Figure 2. Specifically, In the maximum lag period, the overall effect of the average temperature on Varicella showed a W-shaped curve, reaching the peak value at 17.5°C (RR=2.085, 95%CI: 1.480-2.937).

The impact of extreme temperature variables on varicella risk on various lag days was also examined by some of the experts (Figure 3). Varicella has an S-shaped relationship with extremely low temperatures and a W-shaped relationship with extremely high temperatures. The relative risk of extremely low-temperature treatment peaked on the sixteenth day of hysteresis and finally dropped to its lowest on the twenty-first day. Additionally, on day 21 of the lag period, the impacts of exceptionally high temperatures peaked. The pictures show that at low temperatures, the relative risk is higher at the 1st percentile and at the 99th percentile. In contrast, low temperatures had a stronger and longer-lasting effect on Varicella than did high temperatures [5]. Furthermore, using the minimum Varicella temperature of 25°C as a reference point, Figure 4 illustrates the three-dimensional association between daily temperature and Varicella instances during a 21-day period. Varicella was found to have a nonlinear relationship with temperature. At both high and low temperatures, the pictures simultaneously displayed a comparable inverted U-shaped hysteresis pattern [1]. In conclusion, the infectivity of varicella is directly correlated with temperature in the majority of Chinese cities, and this correlation will also alter based on regional variations in temperature.

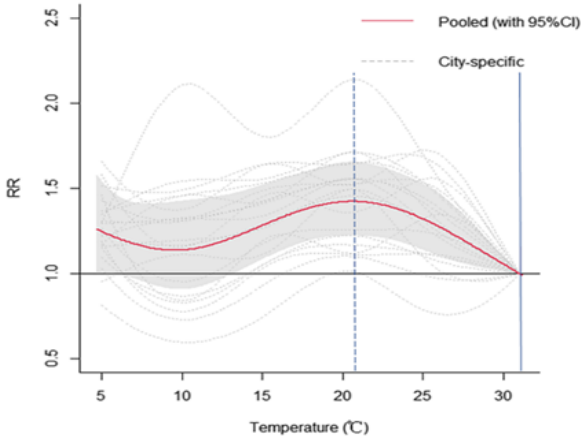


Figure 1. shows the combined overall temperature-varicella association curves for 21 cities in Guangdong Province, China, from 2011 to 2019. (The reference value is shown by the solid blue lines, while the value that corresponds to the maximum relative risk (RR) with statistical significance is shown by the dotted blue lines.)

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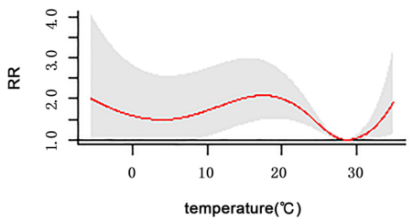


Figure 2. The overall effects of mean temperature on varicella incidence within 21 days of mean temperature

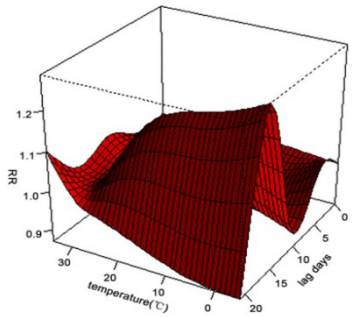


Figure 3. 3D plots of relative risk of mean temperature on varicella incidence within 21 days

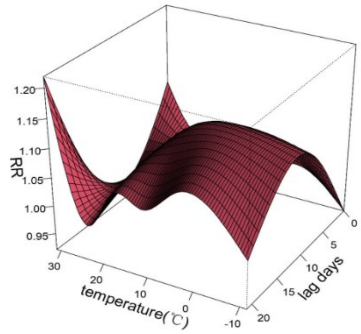


Figure 4. Three-dimensional plot of the relationship between mean temperature and varicella within 21 lag days.

2.2. Gender and age influence transmission rates

There are numerous examples of study efforts in this area because, in addition to environmental factors like temperature, human factors like age and gender can also impact the infectivity of varicella. Different age groups have varying rates of Varicella visits. Children aged 1–4 years had the highest average weekly visits from 2017–2019 (41.90 per 100,000), followed by infants under 1 year (31.49 per 100,000) and adolescents aged 5–14 years (9.73 per 100,000). However, just these three age groups accounted for over 90% of all visits. This is sufficient to demonstrate that babies and certain teenagers with weakened immune systems are susceptible to varicella. This result may be readily formed because the percentage of individuals infected by age groups did not change significantly during COVID-19, with the exception that children aged 1-4 years had a higher consultation rate than infants under 1-year-old (Figure 5, Figure 6, Table1) [3]. Although the rates are similar generally, Table 1 shows that men are slightly more likely than women to be infected [3]. Another study, however, found that the age group most at risk was 6–10 years, followed by 1–5 years, 11–15 years, 16–20 years, and those beyond 20 years (Table 2). Similar to the earlier findings, it was discovered that men were still marginally more contagious than women when compared to the circumstances of various genders [6].

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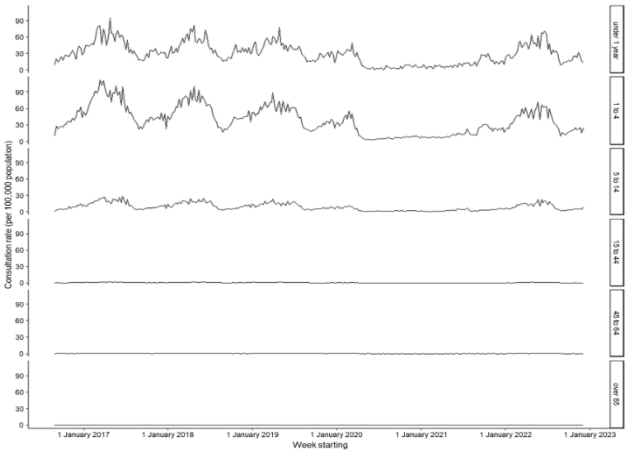


Figure 5. Weekly consultation rate for Varicella per 100,000 registered population from participating general practitioners (GPs) contributing to the GP in-hours (GPIH) syndromic surveillance system, by age group, 1 September 2016 to 9 December 2022.

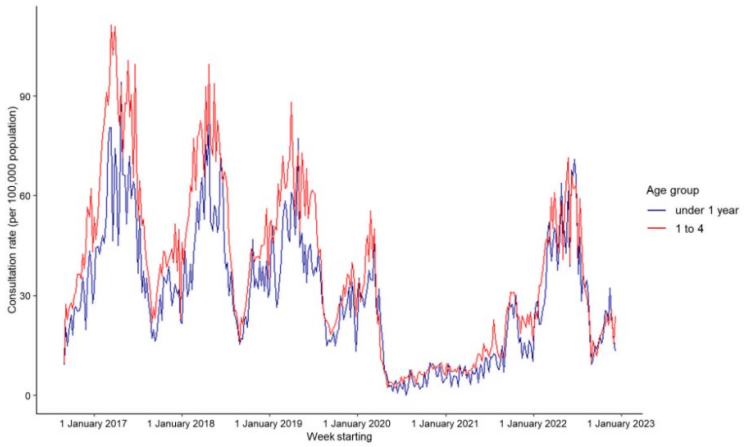


Figure 6. Varicella consultation rate per 100,000 registered population per week for infants under 1 year old and children aged 1-4 years old, from 1 September 2016 to 9 December 2022, from participating general practitioners (GPs) contributing to the GP in-hours (GPIH) syndromic monitoring system.

Table 1. shows the mean weekly consultation rates and rate ratios for varicella for the pre-COVID-19 and COVID-19 periods by age group and sex among participating general practitioners (GPs) who contribute to the GP in-hours syndromic surveillance system.

	Whole Study Period (1 September 2016 to 9 December 2022)		**Pre COVID - 19 (1 September 2016 to 8 March 2020)**		**Post COVID – 19 (9 March 2020 to 9 December 2022)**	
Characteristic	Rate per 100,000	RR^{-1}	Rate per 100,000	RR	Rate per 100,000	RR
Age						
<1	29.53	-	31.49	-	24.41	-
1 to 4	38.01	1.29	41.90	1.33	27.86	1.14
5 to 14	8.96	0.30	9.73	0.31	6.97	0.29
15 to 44	0.67	0.02	0.73	0.02	0.50	0.02
45 to 64	0.19	0.01	0.21	0.01	0.13	0.01
Over 65	0.09	0.00	0.10	0.00	0.06	0.00

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Table 1. (continued).

Sex						
Male	3.43	-	3.81	-	2.44	-
Female	3.38	0.99	3.74	1.02	2.45	1.00

Table 2. The variable of Varicella

Sex wise distribution	**Total cases**
Male	1463 (57.28)
Female	1091 (42.72)
Age-wise distribution	Total
<1	22 (0.87)
1 - 5	436 (17.08)
6 – 10	709 (27.74)
11 - 15	402 (15.74)
16 – 20	268 (10.51)
21 – 25	259 (10.14)
26 - 30	231 (9.05)

3. A Key Measure To Prevent Varicella Infection—Vaccination

Varicella is one of the most prevalent and extremely dangerous viral diseases, and vaccination is the most widely used form of protection for patients with immunodeficiency conditions, who depend on immunoglobulins to ward off common infectious diseases. Because immunoglobulin (IVIG) products are made from plasma pools gathered from numerous healthy donors, they contain antibodies against a wide range of infectious agents. When administered intravenously, these antibodies can help patients with impaired antibody production avoid contracting bacterial and viral infections [7]. The vaccination, which can be administered either alone or in conjunction with the measles, mumps, and rubella (MMRV) vaccine, is the most effective method of preventing varicella [8]. Healthcare personnel who are not vaccinated run the danger of spreading Varicella to their patients and coworkers, therefore vaccination will help stop the spread of the disease [9]. Varicella vaccines have proven to be very efficacious, safe, and cost-efficient since widespread use [8]. However, one of the possible disadvantages of vaccination is that the degree of antibody protection brought about by the varicella vaccine may wane over time [8]. Another disadvantage is that the vaccination is not 100% successful in preventing varicella, according to cohort studies of children, which reveal that it is 84% to 86% effective [10].

4. Conclusion

This essay has solved the problem of factors affecting Varicella infection. As for the temperature factor, according to the research, temperature change can indeed affect Varicella infection, and Varicella infection is also different in different temperature changes in various regions of China. For individual factors, infection rates are particularly high in groups such as infants and children under 16 years of age because of their low immunity, and for gender, males are generally slightly more affected than females. At the same time, the essay puts forward the most effective and universal method to prevent Varicella by vaccination and evaluates the advantages of the vaccine's high efficiency and inhibiting infection, as well as the disadvantages of the vaccine's duration of action and not 100% effect. For this study, the disadvantage is that the research area is only limited to China, so future research can focus on the whole world. Meanwhile, only temperature, sex, and age were mentioned in the study, but in fact, there are many more factors affecting Varicella infectivity, which need to be studied later. Furthermore, in addition to vaccination, other physical and chemical methods are not mentioned in the prevention of Varicella, which needs more research and data to prove. Therefore, future research on Varicella, the

factors affecting Varicella infection, the improvement of vaccine problems, and other advanced preventive measures besides vaccines are important research directions.

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