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# *Analysis of the Seasonal Distribution Characteristics of Hand, Foot, and Mouth Disease in a Southern China*

**Jinqi Yan**[1,a,*]

[1]*Stony Brook Institute, Anhui University, Hefei City, Anhui Province, 230000, China*
*a. R22214091@stu.ahu.edu.cn*
**corresponding author*

***Abstract:*** Hand, foot, and mouth disease (HFMD) is a common infectious disease affecting children, particularly prevalent in Asian countries. In a city in southern China, the annual number of HFMD cases exceeds 40,000, yet this data has not been thoroughly analyzed to date. The Chinese Center for Disease Control and Prevention collected data on HFMD cases in this southern city from 2014 to 2019, with cases recorded on a monthly basis. We aimed to analyze the seasonal distribution characteristics of HFMD in the city using two methods: the Concentration Method and the Seasonal Index Method. The study aims to fill the existing data gap and provide insights for developing effective prevention and control strategies. Over the six-year period from 2014 to 2019, a total of 187,887 cases of HFMD were reported in the province. The average annual incidence rate was 48.94 per 100,000 population. The concentration ratio (M) was calculated to be 0.335, with annual M values ranging from 0.151 to 0.554, indicating a significant degree of seasonality in the incidence of HFMD. The seasonal index (C) exceeded 100% from April to July, peaking in June at 228.418%, which suggests that the epidemic season for HFMD in this city is from April to July. Given the distinct seasonal characteristics of HFMD in the southern city, it is imperative that prevention and control measures are implemented in advance of the peak season. Concurrently, robust surveillance and early warning systems should be maintained to mitigate the spread of HFMD and prevent outbreaks.

***Keywords:*** HFMD, Epidemiological characteristics, Seasonal characteristics, Concentration Method, Seasonal Index Method

## 1. Introduction

Hand, Foot, and Mouth Disease (HFMD) is a common childhood infectious disease caused by enterovirus infection, with high infectivity and seasonal epidemic characteristics. In recent years, the incidence of HFMD has shown an increasing trend around the world, especially in Asia. Because of its unique climate and geographical environment, the southern region has become one of the key areas with high incidence of HFMD. Although existing studies have shown that the incidence of HFMD has obvious seasonal distribution characteristics, the specific seasonal distribution patterns and influencing factors are still different in different regions and cities. Existing studies mainly focus on the epidemic characteristics, transmission mechanism and prevention measures of HFMD, but there are few studies focus on the seasonal distribution rules, epidemic peaks and epidemic trends of HFMD. In this text, the data on HFMD in a city in southern China from 2014 to 2019 was selected as the

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research object, and the seasonal distribution characteristics [1-2] of HFMD in this area were analyzed by statistical methods such as Concentration Method and Seasonal Index Method, then provide reference for public health departments to formulate specific prevention and control strategies.

## 2. Methods

The case information of HFMD was obtained from the Chinese Center for Disease Control and Prevention. Selecting all case reports of HFMD in a southern city from January 1, 2014 to December 31, 2019.[3]

In this study, the seasonal characteristics of HFMD were quantified by the Concentration Method and Seasonal Index Method.

### 2.1. Concentration Method

The concentration method [4] is a commonly used statistical analysis method, mainly used to measure the concentration of distribution of a certain phenomenon in space or time. Through Concentration Method, this text can analyze the centralized and decentralized states of the research object in different dimensions, thereby revealing its distribution characteristics and rules. In epidemiological studies such as HFMD, the Concentration Method can be used to analyze the distribution characteristics of the disease in different times and spaces. For example, the concentration method can confirm the seasonal concentration of HFMD in a city and find out the peak or high incidence area. This has important guiding significance for formulating effective disease prevention and control strategies. The calculation method is as follows:

$$M = \sqrt{R_x^2 + R_y^2} \tag{1}$$

$$R_x = (r_2 + r_6 - r_8 - r_{12})/2 + \sqrt{3}(r_3 + r_5 - r_9 - r_{11})/2 + (r_4 - r_{10}) \tag{2}$$

$$R_y = (r_3 + r_5 - r_9 - r_{11})/2 + \sqrt{3}(r_2 + r_{12} - r_6 - r_8)/2 + (r_1 - r_7) \tag{3}$$

$$r_i = f_i/n \tag{4}$$

In the above equation, M is the concentration[5], R is the dispersion, n is the number of cases in the whole year, fj is the number of cases in a certain month, rj is the ratio of fj to n, and j is the month. When M=1, the incidence of HFMD was concentrated in one month in one year. When $1>M\geqslant 0.9$, HFMD had strict seasonality. When $0.7\leqslant M<0.9$, HFMD had strong seasonality. When $0.5\leqslant M<0.7$, HFMD had strong seasonality. When $0.3\leqslant M<0.5$, HFMD had a certain seasonality. When $M<0.3$, the seasonality of HFMD was poor.

### 2.2. Seasonal Index Method

The seasonal index method[6] is a time series analysis method that is mainly used to reveal and quantify seasonal variation patterns in data. It calculates the seasonal index to reflect change rules of a certain phenomenon in different seasons or periods, thereby helping identify the periodic fluctuation characteristics of the data. Through the seasonal index analysis of the time series data of HFMD incidence, the high incidence season and the changing trend of incidence intensity of HFMD in a year can be confirmed. Meanwhile, the reference basis for disease prevention and control can be provided. The calculation method is as follows:

$$c = \frac{A}{B} \times 100\% \tag{5}$$

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In the above formula, C is the seasonal index, A is the average number of cases in the same month of each year, and B is the average number of cases in all months of each year. When C⩾100%, it is a popular season; when C<100%, it is not a popular season.

### 2.3. Statistical analysis

The seasonal characteristics of HFMD were analyzed using descriptive epidemiological methods. The WPS table (version 12.1.0.16929) was used to organize data and draw charts, and use it to calculate M and C values.

## 3. Results

### 3.1. Descriptive analysis

From 2014 to 2019, a total of 187,887 cases of HFMD were reported in a southern city, with an average annual incidence of 48.94/100,000. In a southern city, the Hand, foot, and mouth disease (HFMD) epidemic remains at a low level in January and continues to decline in February, reaching the lowest level of the year. The epidemic begins to rise in March, typically peaking in June, and cases start to decline significantly in July. The total number of incidences of HFDM in the same month of each year reported in a southern city from 2014 to 2019 was mapped by a column diagram. The results of the column diagram in figure 1 showed a unimodal distribution, which met the premise of using the concentration method, seasonal index method, and circular distribution method for analysis.

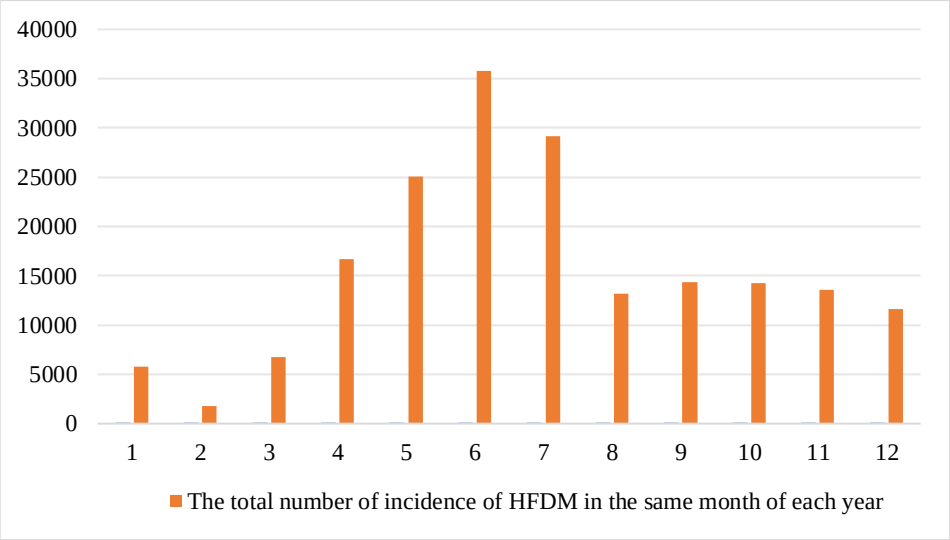



Figure 1: The total number of incidence of HFDM in the same month of each year

### 3.2. Concentration analysis

Based on the number of reported cases of HFMD in a southern city, the total M value of each year and 5 years from 2014 to 2019 was calculated, respectively. The results showed that the total Rx of 16 years was 0.059, Ry=-0.330, M=0.335, and the value of M value of each year ranged from 0.281 to 0.787. It has a certain seasonality.

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### 3.3. Seasonal Index analysis

From April to July of each year from 2014 to 2019, the seasonal index C>100% belongs to the epidemic season of Hand, foot and mouth disease. Among them, the highest value can reach 228.418% in June. The seasonal index of HFMD from January to March and from August to December in Henan Province was <100%, which belonged to the nonepidemic season. The seasonal index of HFDM reported in a southern city from 2014 to 2019 was mapped by radar map. The results of radar map in figure 2 showed unimodal distribution, which met the premise of using seasonal index method for analysis.

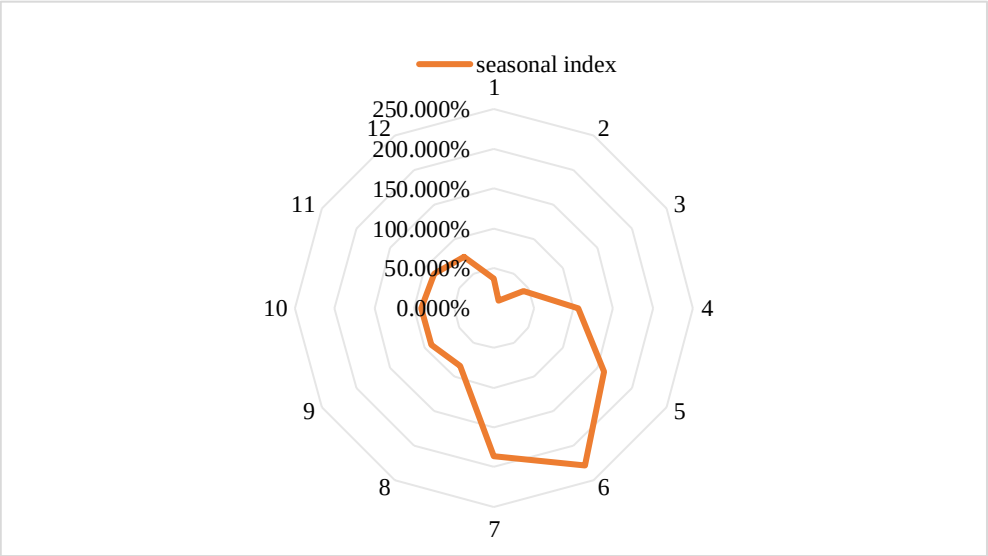



Figure 2: Radar map

## 4. Discussion

The epidemic period of HFMD is closely related to the climate in southern China. HFMD is an infectious disease caused by a variety of enteroviruses. Appropriate temperature and humidity will promote the proliferation of these viruses in the external environment and enhance their survival ability, thereby increasing the risk of HFMD [7]. In the city, the sunshine and temperature are obviously high from April to September every year, and with the rising temperature, the reproduction and mutation rate of enterovirus will be accelerated, thus increasing the possibility of infection with hand, foot, and mouth disease [8-11]. Studies have shown that when the air humidity is >57% and the lag days are >5 days, the incidence risk of HFMD increases with the increase of relative humidity [7-11]. Therefore, the seasonal characteristics of HFMD are related to factors such as annual climate conditions [10-11].

In general, in the high incidence season of HFMD, prevention and control measures should be strengthened in crowded places such as kindergartens and schools, focusing on changes in temperature and humidity to reduce the risk of disease transmission. At the same time, an early warning system for HFMD should be formulated, the potential high incidence period should be predicted according to the meteorological data, and prevention measures should be taken in advance.

## 5. Conclusion

Results showed that the average incidence of HFMD in a southern city from 2014 to 2019 was 48.94/100,000. The time distribution of the disease was usually described roughly by using the

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number of cases or the incidence, which could not systematically explore the seasonal distribution characteristics of the disease and could not obtain a clear peak period of disease incidence. But the Seasonal Index Method and the Concentration Method belong to the statistical description method, and each has its own advantages in analyzing the seasonal distribution characteristics of diseases. This study used the Concentration method and Seasonal Index Method to analyze the incidence of HFMD in a southern city from 2014 to 2019. The M value calculated by the concentration method was 0.335, indicating that the incidence of HFMD in the city had certain seasonal characteristics. The seasonal index method showed that the epidemic period was from April to July, which was consistent with the incidence peak shown by the incidence radar map.

However, there are some limitations in this study. First, due to limited data sources, the study does not fully consider other factors that may influence the incidence of HFMD, such as population density, sanitary conditions, and socioeconomic factors. Secondly, this study mainly focuses on a single city, and the universality of the research results needs to be further verified. Future studies should conduct more comprehensive analyses on a larger scale and longer time scale, combining multiple data sources, in order to improve the understanding of the seasonal epidemic law of HFMD.

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