

# The Seasonal Drivers of Hand, Foot, and Mouth Disease in Thailand

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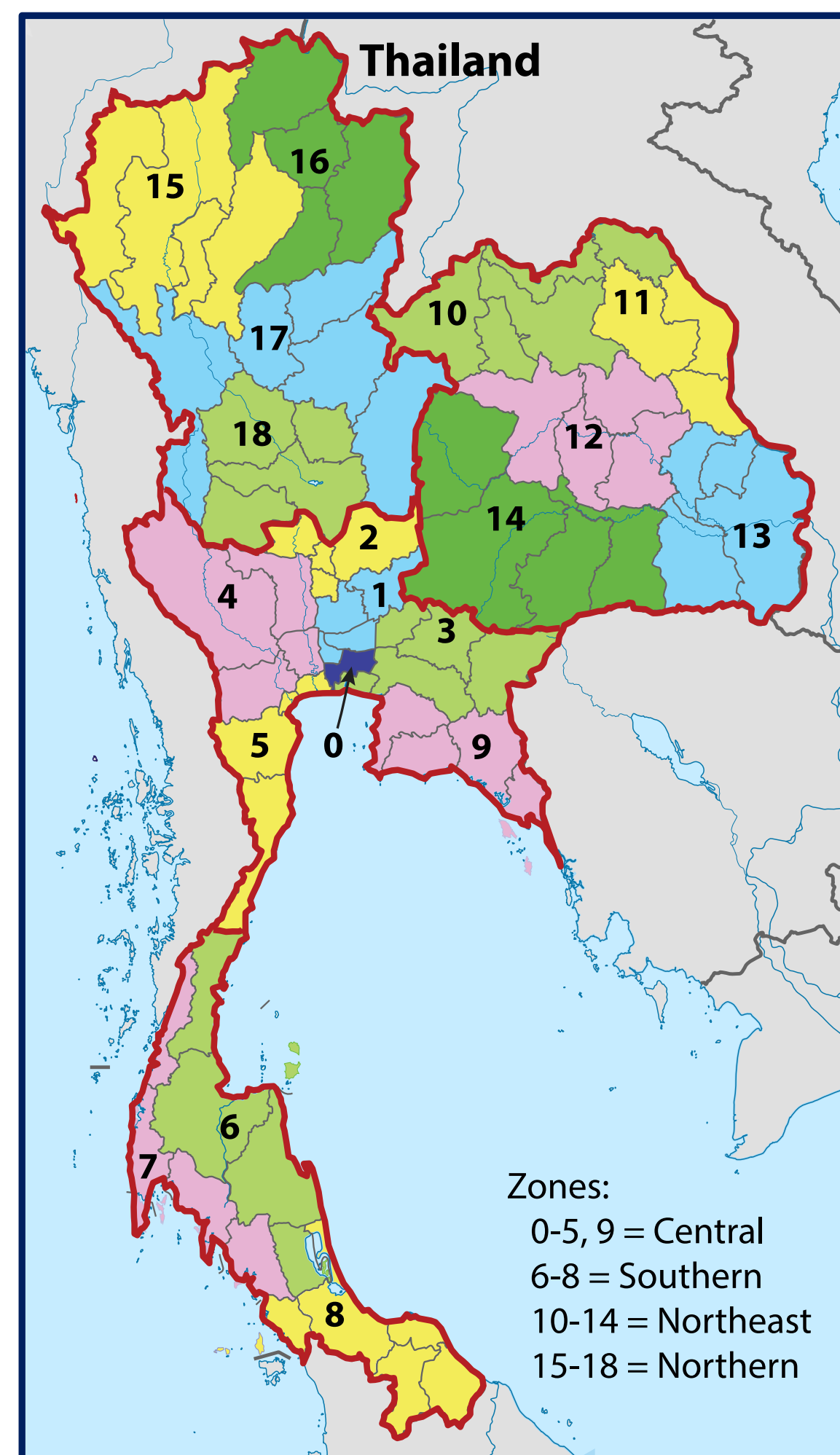
## Abstract

In recent years, Hand, Foot, and Mouth Disease (HFMD) has emerged as a serious public health issue in Thailand with nearly 80,000 cases in 2016 alone (1). This is nearly double the number of cases seen in the previous year. HFMD continues to be transmitted throughout Thailand without a conclusive explanation for its seasonal pattern. The main purpose of this study is to understand the seasonal dynamics of HFMD in Thailand, which will provide further insight into the epidemiology of the disease. Time series analyses indicated that HFMD exhibits a strong seasonal pattern across the entire country, with a significant peak in cases in July. Age structure analyses revealed that on average, 89.2% of cases occurred in children under 5 years and 57% of HFMD cases were found in children aged 1-2. Incidence rates from across the country demonstrated an increasing trend of HFMD in Thailand, with an extremely large number of cases reported in the last few years.

## Background

HFMD is particularly concerning because no available vaccine exists, most cases are seen in children under five years, and infection can cause permanent cardiac or neurological damage. Following several years of outbreaks, international meetings were held to develop surveillance systems and strategies for combating HFMD in Southeastern Asia and the Western Pacific (2). Previous studies have reported that positive correlations exist between the incidence of HFMD and environmental variables such as temperature, humidity (3,4), and rainfall (5).

Figure 1.



## Methods

Monthly HFMD cases and annual age structure data were digitized from the Thailand Ministry of Public Health website from the years 2003-2015 (1). The 76 Thai provinces were divided into 19 zones (0-18, Fig. 1), with Bangkok representing zone 0. The 19 zones were further separated into one of four regions: Central, Southern, Northeast, and Northern, indicated by the red lines. Time series, general additive models, and incidence rates were created for each zone, region, and the entire country. GAM plots were constructed using data from 2010-2015, when cases became abundant. Age distribution was calculated for ages under 1 year, 1-2 years, 2-3 years, 3-4 years, 4-5 years, and over 5 years from 2003-2015.

## Results

Figure 2.

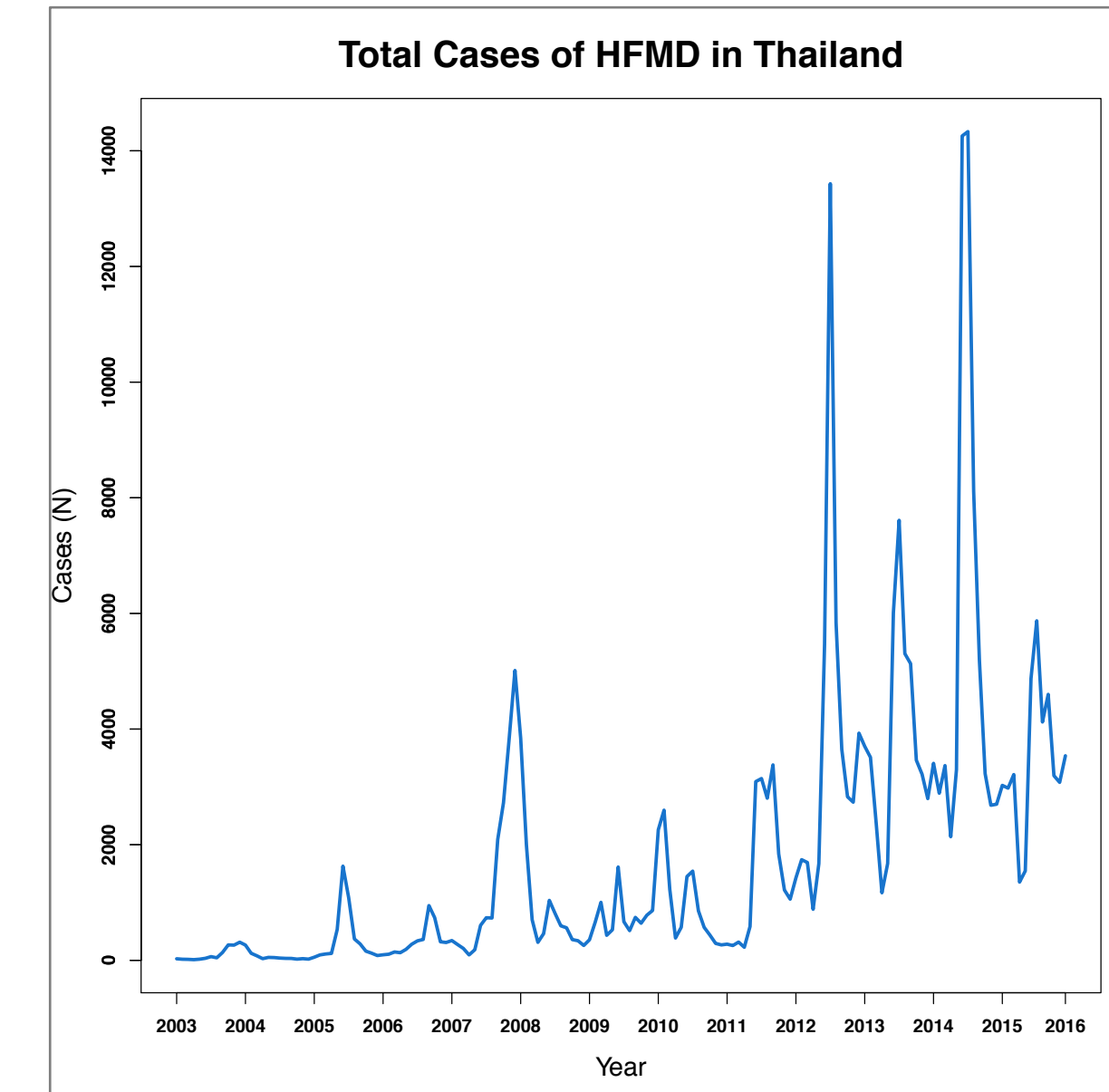
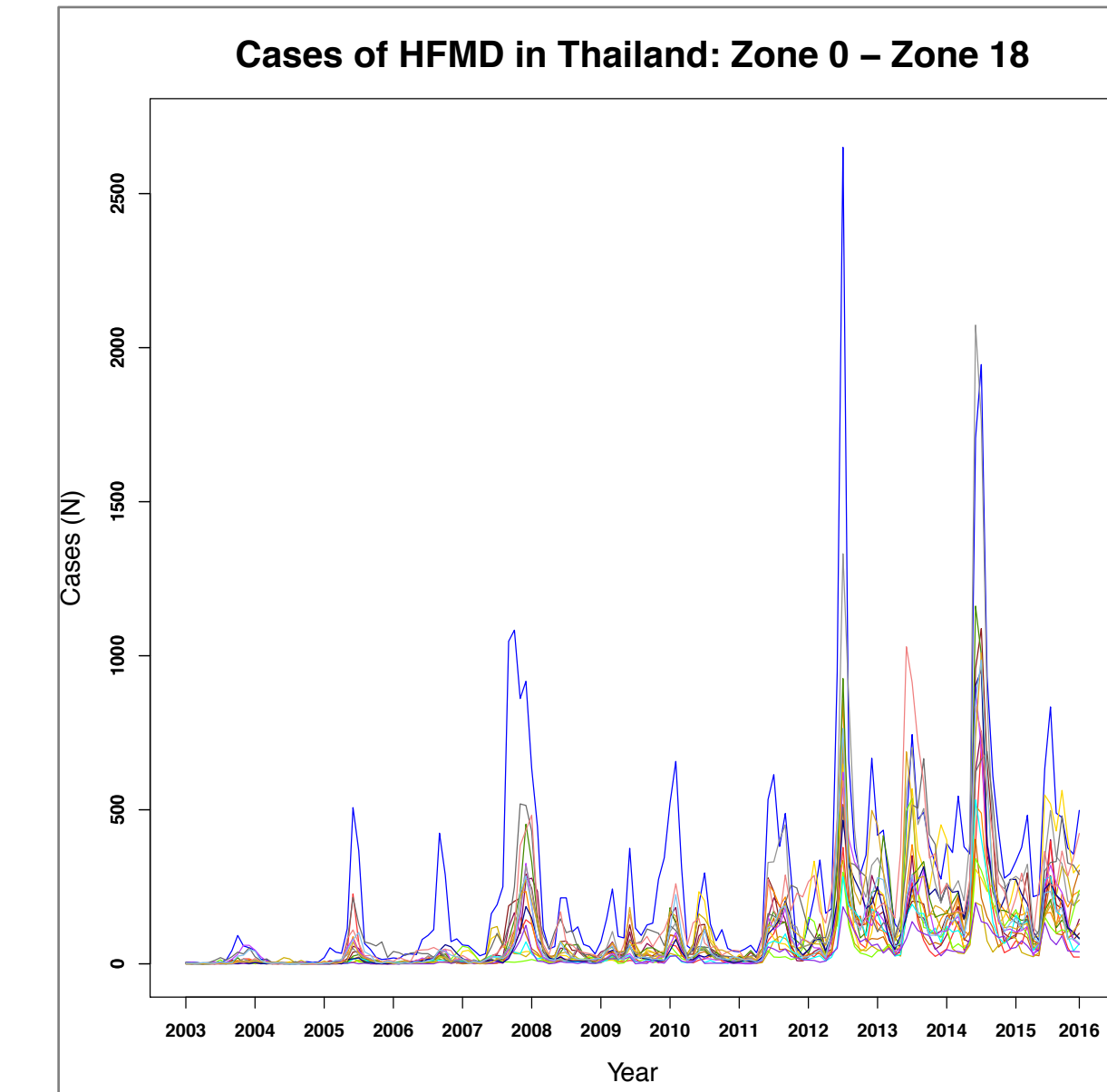
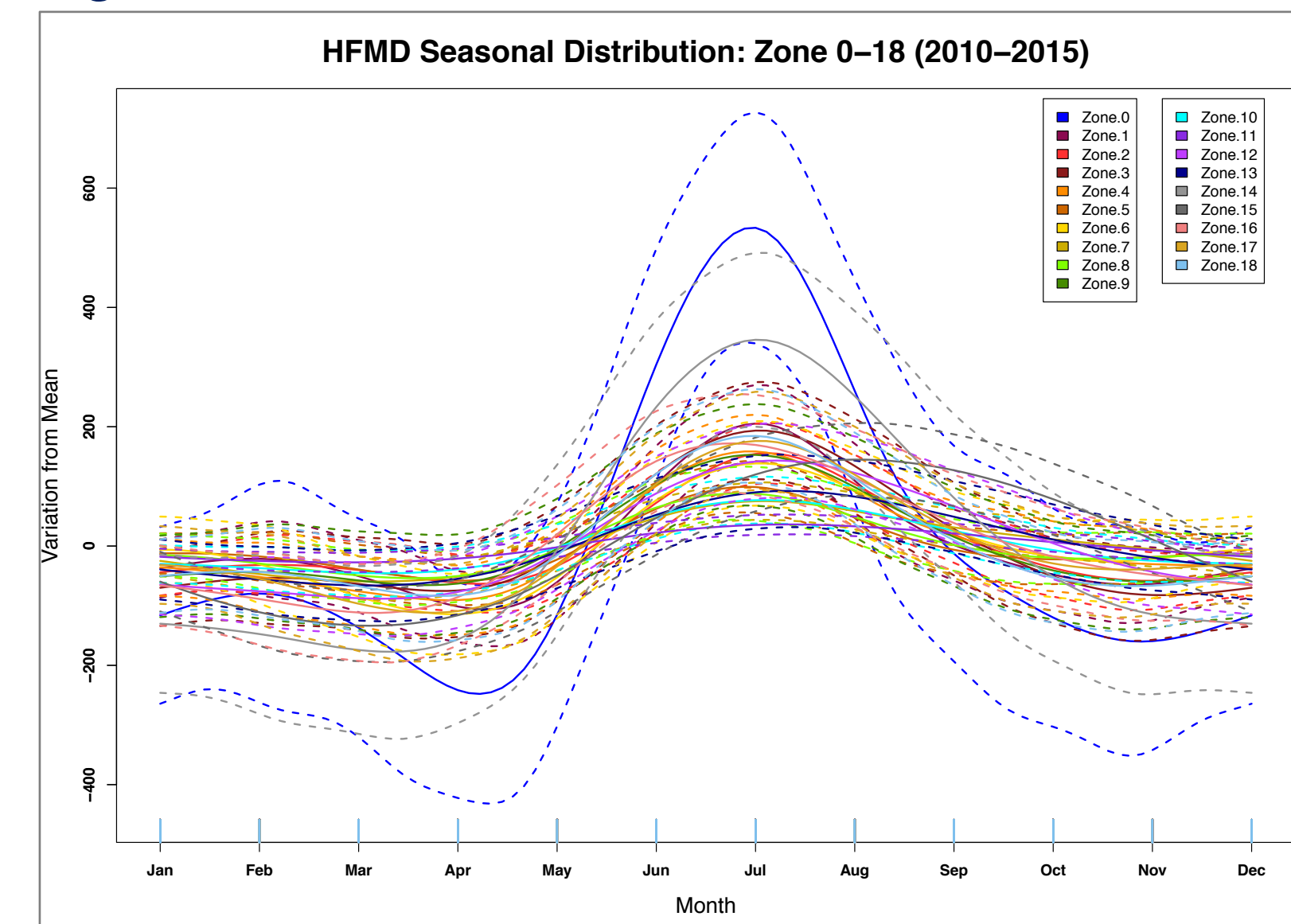


Figure 3.



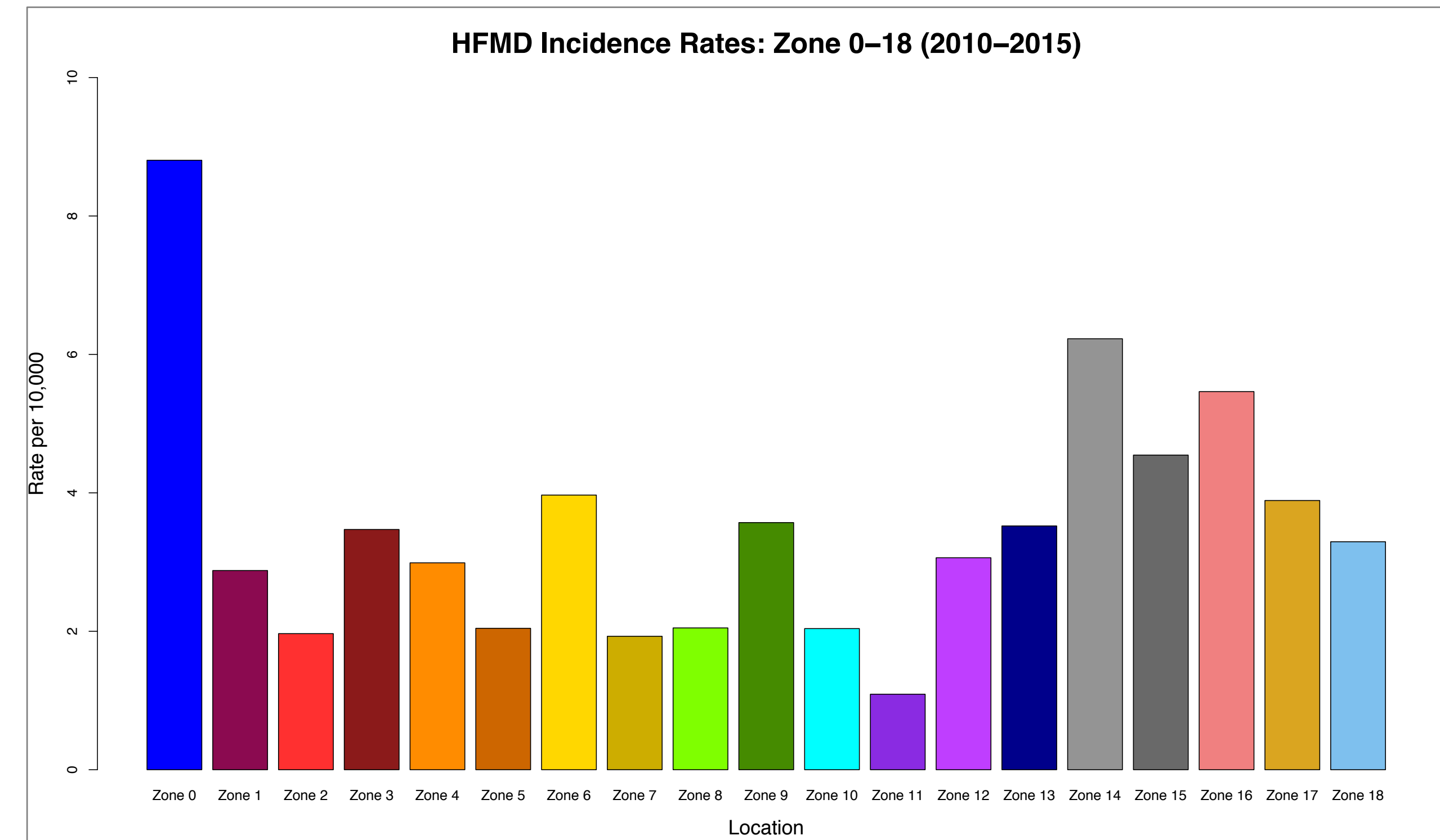
HFMD time series of Thailand and each of the 19 zones. HFMD exhibits an increasing trend in cases and an annual peak midway through the year.

Figure 4.



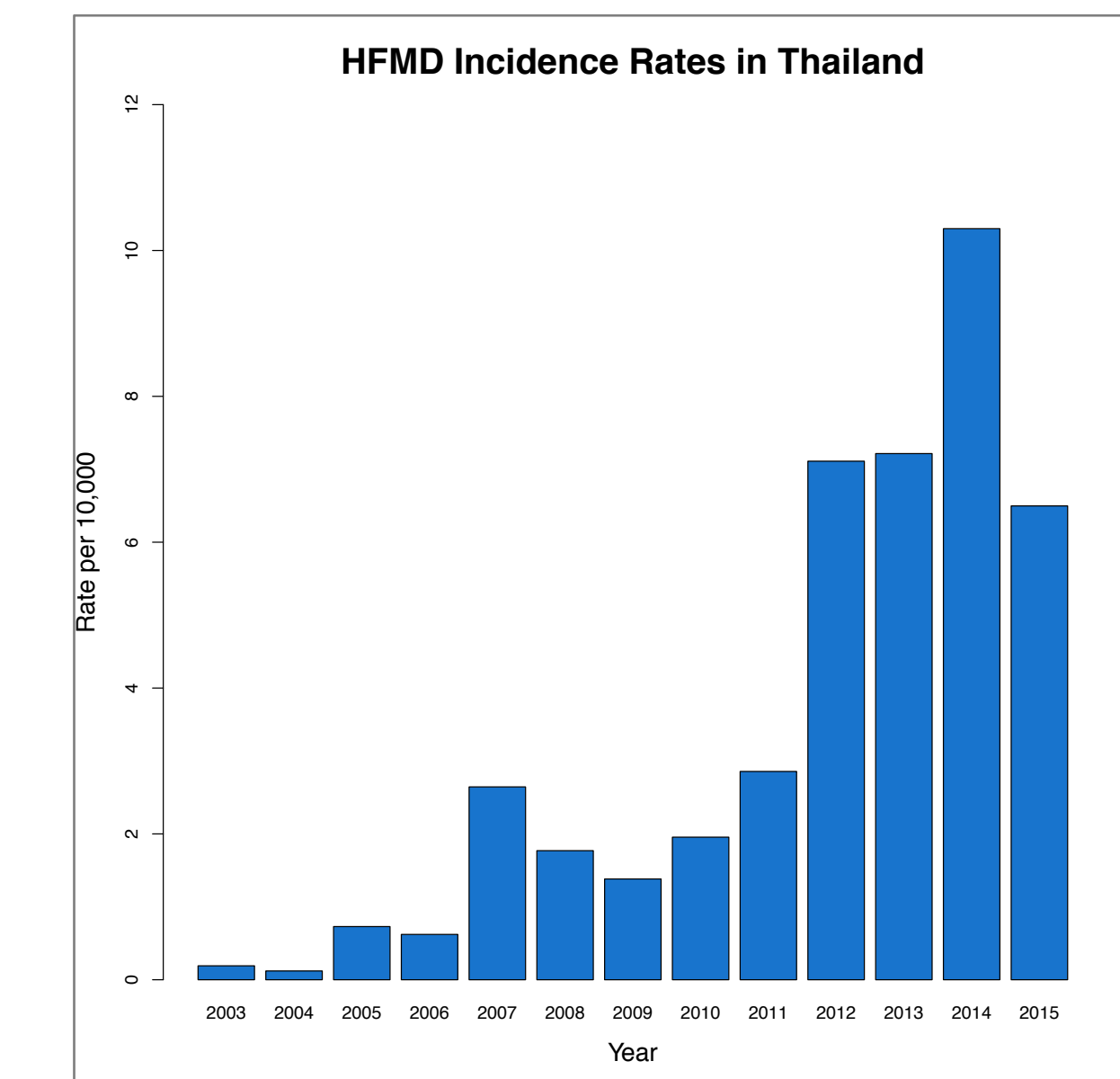
General additive model (GAM) demonstrating the seasonality of HFMD in each zone. The number of cases seen in July is significantly different than other months. Zone 0 (Bangkok) is the blue curve exhibiting a strong seasonal pattern.

Figure 5.



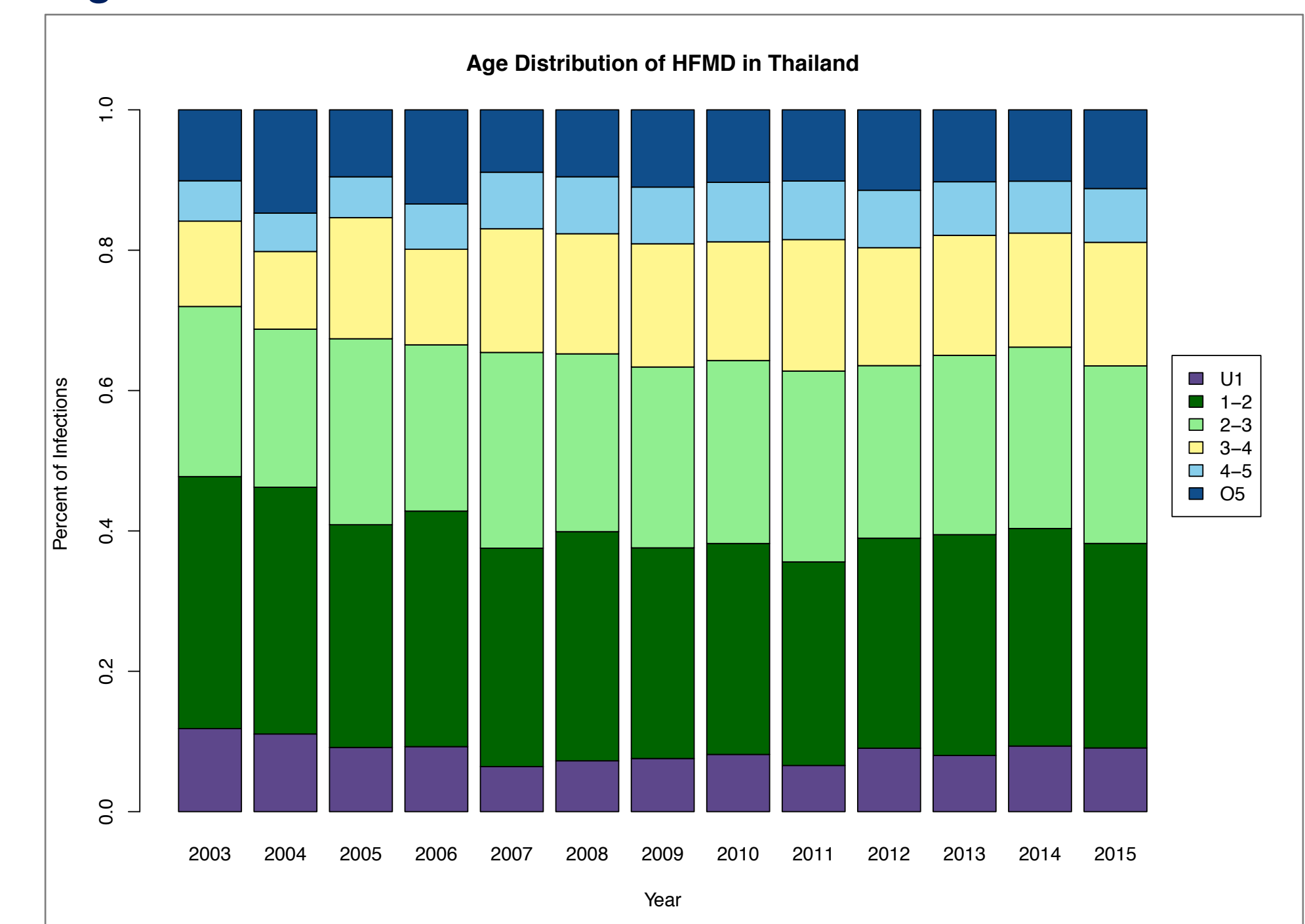
HFMD incidence rates in all 19 zones. Zone 0, city of Bangkok and most populated zone, has the highest incidence rate of HFMD. Zone 14 is the second most populated zone and it displays the second highest incidence rate.

Figure 6.



Incidence rates of HFMD in Thailand from 2003-2015. The figure shows an overall rise in incidence rate of HFMD for the time period.

Figure 7.



Age distribution of HFMD in Thailand from 2003-2015. On average, 89.2% of all HFMD cases presented in children under the age of 5. The majority cases (57%) occurred in children aged 1-2.

## Next Steps

Now that we have a full understanding of HFMD dynamics in Thailand, our next steps will link HFMD seasonality to environmental (temperature, rainfall, and humidity) and social (term-time forcing) covariates. Finally, we will build mechanistic models to fit current, and forecast future, cases of HFMD in Thailand. This work will identify which, if any, covariate is the primary driver of HFMD seasonality in Thailand.

## References

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