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Climatic Factors Affecting on Influenza Cases in Nakhon Si Thammarat

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Abstract—This study investigated the climatic factors associated with Influenza incidence in Nakhon Si Thammarat, Southern Thailand. Climatic factors comprised of the amount of rainfall, percent of rainy days, relative humidity, wind speed, maximum, minimum temperatures and temperature difference. A multiple stepwise regression technique was used to fit the statistical model. The result showed that the temperature difference and percent of rainy days were positively associated with Influenza incidence in Nakhon Si Thammarat.

Keywords—Influenza, Climatic Factor, Relative Humidity, Rainy day, Wind Speed.

I. INTRODUCTION

INFLUENZA is one of the leading causes of mortality in developing countries [1-3]. Influenza disease is a contagious respiratory illness caused by influenza viruses. It can cause mild to severe illness, and at times it can lead to death. While most healthy people recover from the influenza without complications, some people, such as elderly people, young children, and people with certain health conditions, are at high risk for serious complications from the Influenza. Human Influenza is a disease that is transmitted from person-to-person with droplets generated by coughing. The virus is stable in a dried condition and is also thought to be transmitted by droplet nuclei, which are produced after evaporation of water from the droplets before they fall on the floor [4].

Influenza pandemics also seem to be dependent on environmental or climatic conditions [1, 5-12]. Climatic factors may influence the onset, magnitude and duration of the Influenza season. Climate could affect the abundance of virus reservoirs, reactivate latent infection, the virulence of circulating strains relative to population immunity, or virus survival outside of the human body [1]. In addition, climate may affect human-human contact patterns, susceptibility and infectiousness. The ability to predict epidemic patterns using climate forecasts could have important public health implications.

In Thailand, Bureau of Epidemiology, Department of Disease Control, the Ministry of Public Health reported that Southern Thailand has the highest number of Influenza cases among four regions over a 25 years period. Nakhon Si Thammarat province was one of the top ten provinces in Thailand that has the highest Influenza cases in the year 2005 [13]. In Thailand, few studies have examined how climatic factors affecting on influenza cases. This study aimed at investigating the relationship between climatic factors and Influenza cases in Nakhon Si Thammarat, Thailand.

II. MATERIALS AND METHODS

Nakhon Si Thammarat is one of southern provinces in Thailand located at 7° 49'- 9° 19' N, 99° 14'- 100° 20'E. The province is located on the shore of the Gulf of Thailand on the east side of the Malay Peninsula. The terrain is mostly rugged hilly forest area (Fig. 1). The climate is equatorial and humid with high rainfall, high temperatures of over 20 °C, and relative humidity of 80% throughout the year [14]. The wettest period of the year is from November to January.

Climatic data of Nakhon Si Thammarat from 1981-2005 was provided by the Climatology Division of Thailand Meteorological Department. The monthly Influenza cases data over the same period were collected by Nakhon Si Thammarat, Ministry of Public Health. Monthly climatic data comprised of the amount of rainfall, percent of rainy days, relative humidity, wind speed, maximum, minimum temperature and temperature difference. Monthly climatic data were calculated from daily climatic data. Temperature difference was calculated from the differences between maximum and minimum temperatures. A computer program was written to count and calculate the percentage of monthly rainy days using *Mathematica* Software. The multiple stepwise regression model was employed to explore and identify the climatic factors most strongly correlated with Influenza cases in Nakhon Si Thammarat as in Equation (1).

$$Y = b_0 + b_1X_1 + b_2X_2 + \ldots\ldots + b_nX_n \qquad (1)$$

In which Y was the estimated number of Influenza cases and X_n is the n^{th} meteorological factor on the selected months.

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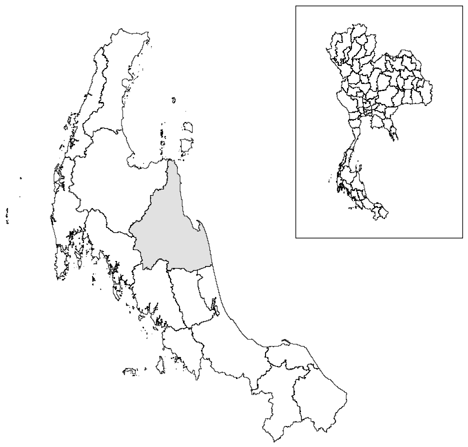

Fig. 1 Map of administrative boundaries of Nakhon Si Thammarat, southern Thailand (shaded area)

III. RESULTS

Influenza incidences per 100,000 populations in Nakhon Si Thammarat varied from 1-1,034 cases with a mean and standard deviation of 249.02±170.14 cases. From 25 years data (i.e. 1981-2005), Influenza incidences per 100,000 populations in Nakhon Si Thammarat were highest in July and lowest in April (Fig. 2).

To determine the optimal climatic conditions for Influenza epidemic in Nakhon Si Thammarat, statistical analysis was derived using the most strongly correlated factor. Therefore, the selected regression model was:

$$Y = 2.11X_r + 36.14X_t - 192.93 \quad (2)$$

In which Y was the estimated number of Influenza incidences per 100,000 populations, and X_r and X_t were the percent of rainy days and the temperature difference on the selected period during which Influenza occurred (Fig. 3).

TABLE I
MULTIPLE STEPWISE REGRESSION OF INFLUENZA CASES WITH CLIMATIC FACTORS IN NAKHON SI THAMMARAT FROM 1981-2005

Variable	Coefficient of regression (B)	SE	Standardized coefficient (B')	t value
Constant	-192.93	109		-1.771
% of rainy day (X_r)	2.11	0.62	0.259	3.383^{*}
Temperature difference (X_t)	36.14	9.39	0.295	3.847^{**}

* Stepwise multiple regression model significantly at $P < 0.05$
** Stepwise multiple regression model significantly at $P < 0.001$

IV. DISCUSSION

Our results support the previous findings that there is a clear cyclical variability of Influenza transmission in Nakhon Si Thammarat. Most previous findings were done in temperate zones and showed that Influenza exhibited distinct seasonality with a higher incidence in winter months and sharp decreases of morbidity and mortality in the summer months [15-17]. The magnitude of morbidity and mortality prevalence varies from season-to-season [15]. This may be because during cold weather, people spend more time inside buildings with limited air space, which favors transmission, and perhaps also because of decreased host resistance [17]. Furthermore, climate factors such as humidity may play a role in the cyclical nature of Influenza, along with the behavioral changes that coincide with more severe winters [16].

A few studies of the relationship between Influenza incidence and climate have been reported in the literature [18-19]. We calculated a regression model for predicting Influenza incidences and climatic factors in Nakhon Si Thammarat. We found that the percent of rainy days and temperature difference factors were positively associated with Influenza incidences. Exact regression models may differ in each province; thus the seasonal model for Nakhon Si Thammarat may not apply for other southern provinces in Thailand.

In temperate zones, temperature linkages to influenza have also been explained by the increased likelihood of indoor interaction (i.e. increased exposure to the virus in a confined airspace) when ambient temperatures are uncomfortably cold, forcing people indoors [20-22]. Our results showed that as the differences between maximum and minimum temperatures increased, the number of influenza incidences increased. This could be due to two possible reasons. First, when there are huge differences between the maximum and minimum temperatures (i.e. temperature differences), this may decrease host resistance [17], second, Nakhon Si Thammarat province has a high percentage of rainy days per month. The temperature difference tends to be greater on rainy days than non-rainy days. As a result, the host immunity may decrease due to temperature differences and wetness from rain.

A climatic association with influenza prevalence a few weeks before the onset of influenza related symptoms or death (i.e. a lagged associated between influenza and climate), may suggest specific patterns to the transmission of influenza. Hope-Simpson [23] proposed that influenza was a latent virus, which erupted according to specific environmental triggering events, such as changes in photo-period (i.e. changes in daylight hours) or temperatures. Our results support Hope-Simpson's findings [23] that Influenza was a latent virus. There was a delayed climatic association and influenza incidences.

To predict the cause of Influenza incidences, a better understanding of associations between climatic factors in the spread of Influenza is essential. The various public health measures are now in place to prevent further outbreaks. However, in the event that subsequent outbreaks occur, additional analysis of the underlying climatic conditions is needed to verify the seasonal nature of the disease.

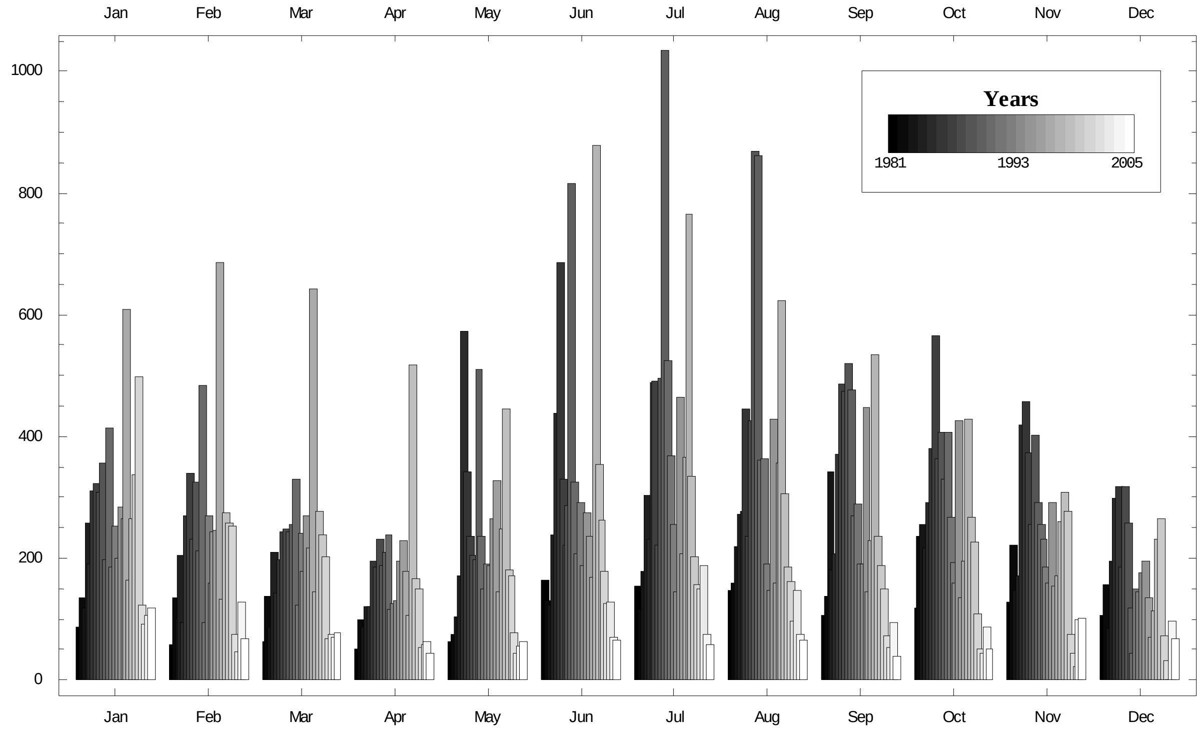

Fig. 2 Monthly Influenza incidences per 100,000 populations for 25 years from 1981-2005. Color gradient ranging from dark level (1981) to light level (2005)

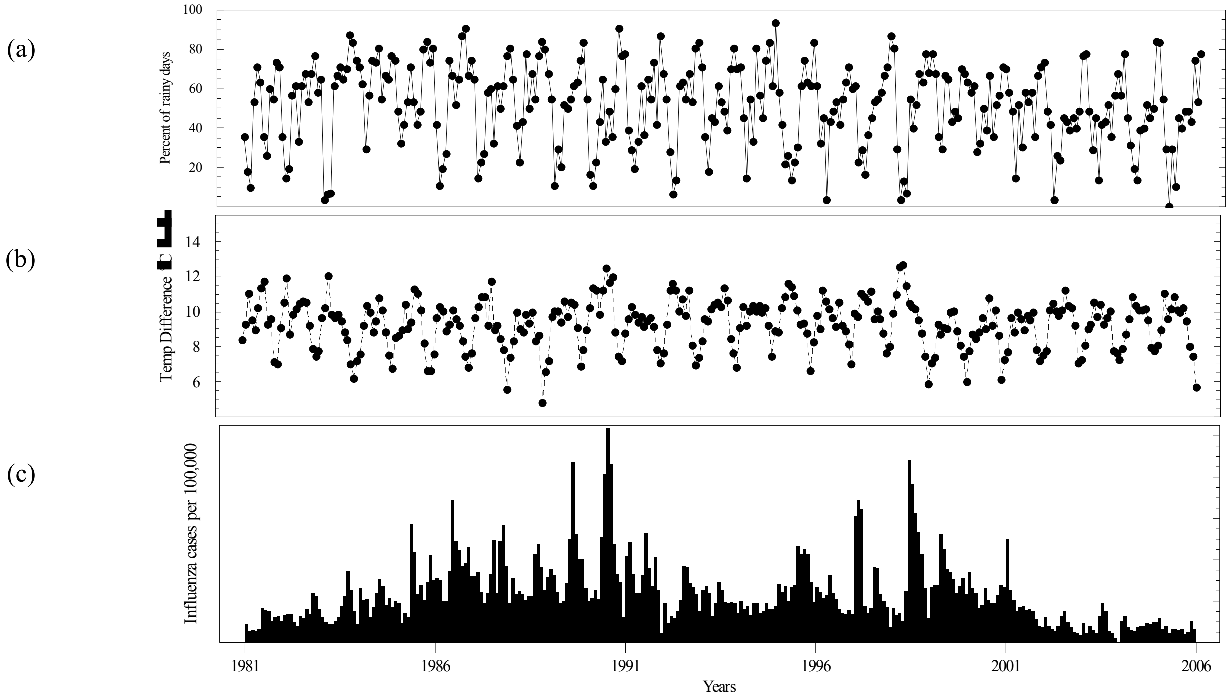

Fig. 3 (a) Percent of rainy days, (b) Temperature differences, and (c) Influenza incidences per 100,000 populations in Nakhon Si Thammarat from 1981 to 2005

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