Chapter 4

Statistical Modeling

This chapter we describe statistical modeling used for estimating suicide mortality rates in southern Thailand during 1996 to 2006. Linear regression and Poisson model were used for modeling and identifying relation of an outcome and determinates. The models were illustrated using appropriate graphs. Sum contrasts were used to obtain confidence intervals for comparing the adjusted mortality rates within each factor with the overall mortality rate. We used this contrasts to create schematic maps of provinces for identifying variations of suicide mortality rate each province.

4.1 Statistical models

Linear regression was the simplest model for fitting mortality rates. For fitting linear regression, we calculated suicide mortality rates per 1000 population according to sex, age group, year and province then transformed using natural logarithm. Zero counts were replaced by 0.01 for avoid logarithm of zero (logarithm of zero is undefined). After fitting the linear regression R-squared was obtained and used for testing goodness of fit. For our linear model R-square was 32%. It indicates that linear model had poor fit.

Poisson models were then considered. For fitting Poisson regression, we used number of deaths as an outcome with corresponding population per 1000 as its offset. After fitting the model residual deviance was obtained. It was 3909.6 with 4274 degrees of freedom then there was no over-dispersion so the Poisson regression model was an acceptable fit.

4.2 Model diagnostic

Figure 4.1 shows plot of studentized residuals versus normal quantiles, the residuals were obtained from linear regression (show in left panel) and plot of deviance residuals for Poisson models (show in right panel). As shown, Poisson model was more appropriate for modeling suicide death rate than linear regression model.

Figure 4.2 shows plots of observed counts and observed mortality rates per 1000 population versus corresponding fitted values obtained from Poisson models. As shown, Poisson model was fit with the data. However, there were slightly points of observed versus corresponding fitted value parted from the lines.

Sum contrasts were used to obtain confidence intervals and we used these contrasts to create schematic maps of provinces according to their estimated suicide mortality rates.

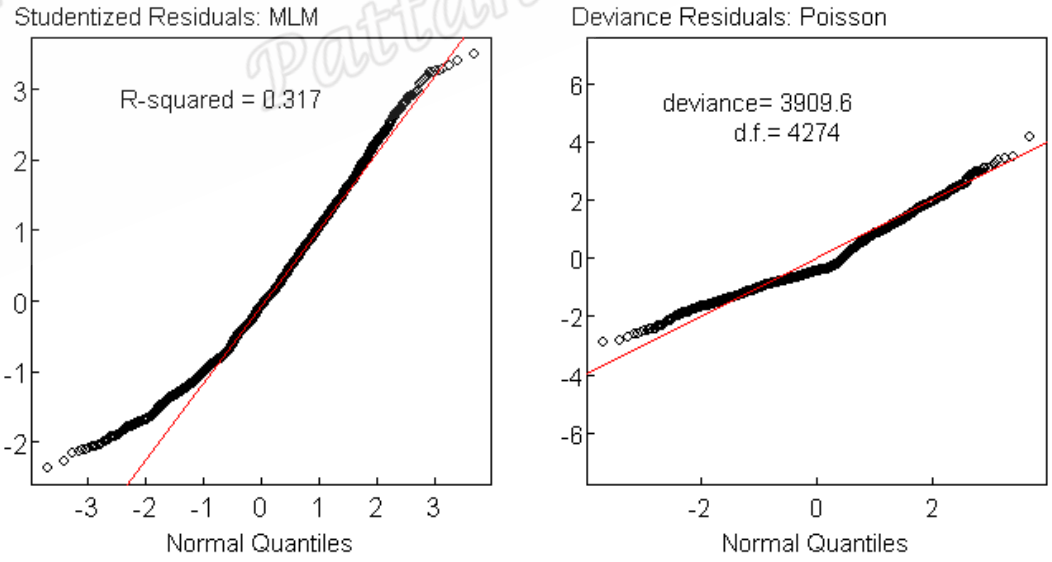

Figure 4.1: Residuals plot from regression model (left panel) and Poisson model (right panel)

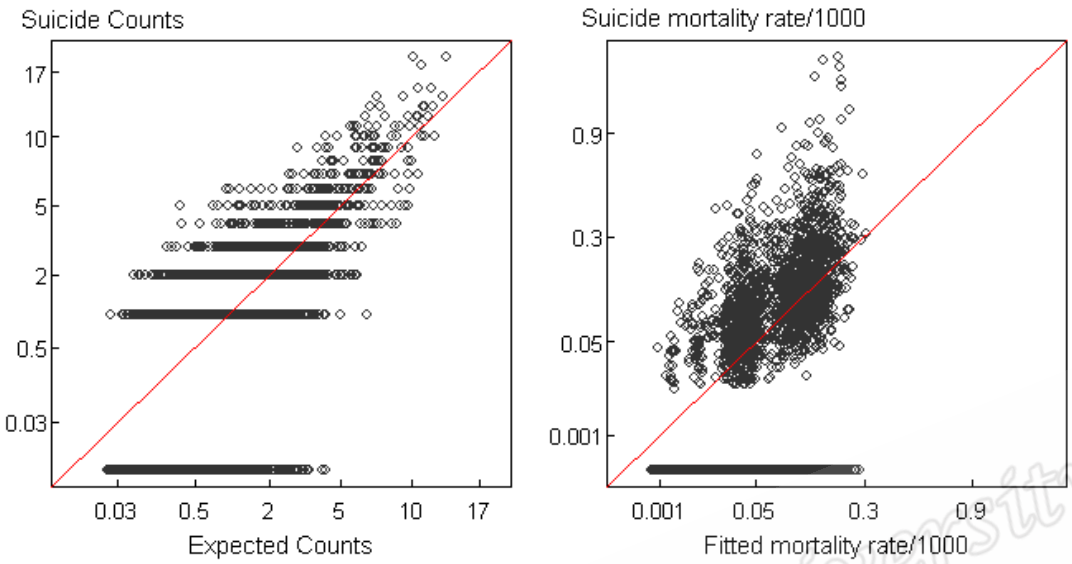

Figure 4.2: Suicide count and expect count plot (left panel) and observe and fitted plot (right panel) from Poisson regression model fitted to suicide mortality rates

Table 4.1 shows the parameters estimates and their standard errors after fitting the Poisson model. The results clearly show that males are more likely to commit suicide than females. The comitted suicide tends to occur between age 20-35 and more than 60 years old. The suicide mortality rates were highest in Chumporn province.

Table 4.1: Regression coefficient and standard errors based on the Poisson regression model fitted to suicide mortality rates in Southern Thailand

Poisson regression model							
Factors	**Coefficient**	**SE**	**P-value**	**Factors**	**Coefficient**	**SE**	**P-value**
Constant	-4.571	0.162	< 0.001	40	2.610	0.160	< 0.001
Sex				45	2.394	0.164	< 0.001
male	0	0		50	2.337	0.168	< 0.001
female	-1.272	0.035	< 0.001	55	2.475	0.169	< 0.001
Year				60	2.792	0.167	< 0.001
1996	0	0		65	2.750	0.171	< 0.001
1997	-0.013	0.072	0.86	70	2.986	0.173	< 0.001
1998	-0.100	0.073	0.17	75	2.937	0.171	< 0.001
1999	0.017	0.071	0.81	**Province**			
2000	0.131	0.069	0.06	80	0	0	
2001	0.101	0.069	0.14	81	-0.212	0.076	0.01
2002	0.001	0.069	0.98	82	-0.241	0.091	0.01
2003	-0.013	0.069	0.85	83	-0.067	0.082	0.42
2004	-0.170	0.071	0.02	84	-0.097	0.051	0.06
2005	-0.128	0.071	0.07	85	0.083	0.094	0.38
2006	-0.275	0.073	0.00	86	0.262	0.056	< 0.001
Age				90	-0.278	0.049	< 0.001
10	0	0		91	-0.647	0.107	< 0.001
15	2.292	0.160	< 0.001	92	-0.001	0.058	0.98
20	2.715	0.158	< 0.001	93	-0.0003	0.061	0.99
25	2.855	0.157	< 0.001	94	-1.543	0.110	< 0.001
30	2.783	0.158	< 0.001	95	-1.195	0.109	< 0.001
35	2.669	0.159	< 0.001	96	-1.563	0.106	< 0.001

The 95% confidence intervals were obtained from Poisson regression model show in Figure 4.3 and Figure 4.4. The graphs show suicide mortality rates /1000 by gender (left panel) and age (right panel) for figure 4.3, by year (left panel) and province (right panel) for figure 4.4 each adjusted for the effects of the other factor in the model. The dotted horizontal lines on each graph represent the overall mean suicide mortality rates (0.063 per 1000 population).

The male suicide mortality rate was slightly higher than female with the male-to-female ratio of 3:1. The age patterns shown the high suicide rates were in the age groups 20-34 and after age 50 and over. The age group with the highest rates of suicide was in the age groups 70-74. The mortality rates have fluctuated since 1996, reaching a peak in 2000 and declining since in 200-2006. Among province, Chumporn, Ranong, Nakhon Si Thammarat, Trang and Phattalung had high mortality rates.

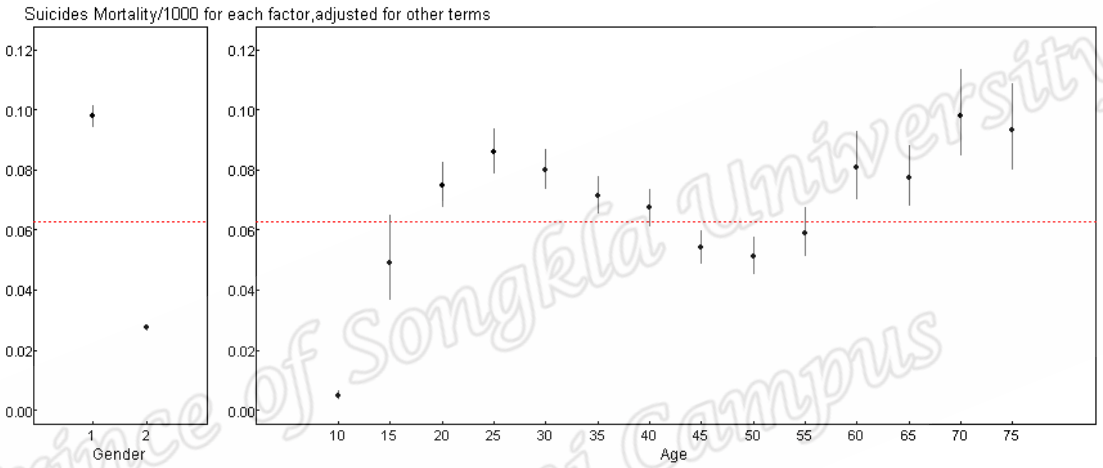

Figure 4.3: mortality rates/1000 by each factor, adjusted for all other factor, left plot for gender and right plot for age

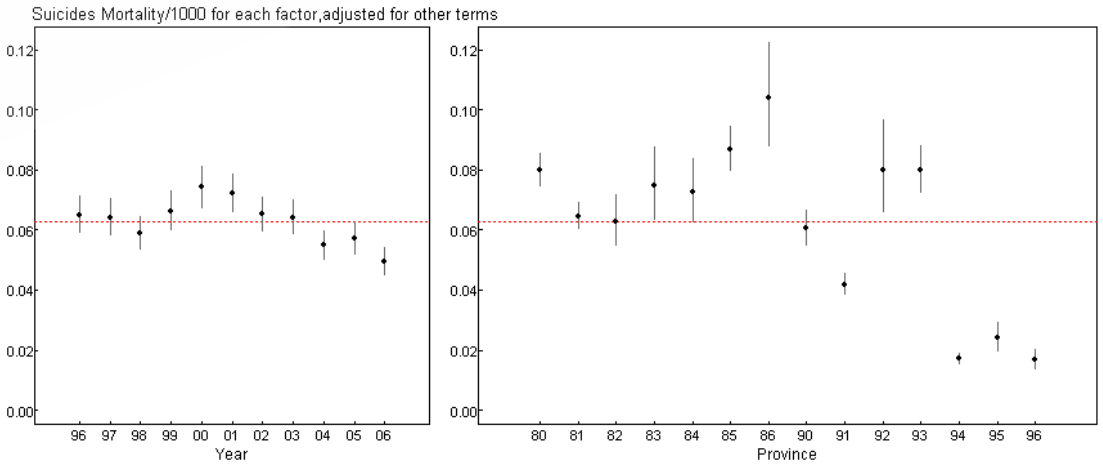

Figure 4.4: mortality rates/1000 by each factor, adjusted for all other factor, left plot for year and right for province

Figure 4.5 shows schematic map of the adjusted mortality rates per 1000 by province, based on confidence intervals. The map shows that Chumporn, Ranong, Nakhon Si Thammarat, Trang Phattalung, Phuket, Surat Thani, Krabi and Phunga had mortality rates significantly higher than the mean.

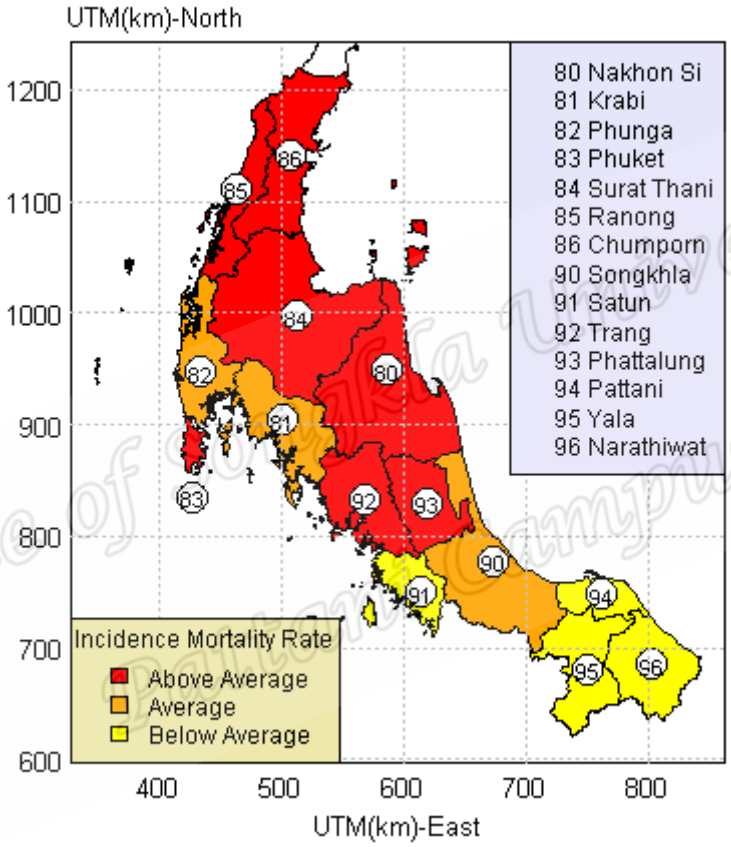

Figure 4.5 Schematic maps of suicide mortality rate for each province