Chapter 4

Statistical Modeling

In this chapter statistical modeling was performed to identify the strength of association between outcome and determinants. Linear regression with logarithmic transformation and Poisson regression were fitted to the road traffic accident data in Southern Thailand and then tested for goodness of fit. The models were stratified by gender. Sum contrasts were used to obtain confidence intervals after fitting the models.

4.1 Models fitting

As discussed already, males had different patterns of accident mortality rate from females. Therefore, the models must be stratified by gender. In addition we excluded "road user" from the models because we could not get corresponding populations for calculating mortality rate or using as offset (in Poisson regression). Therefore, there were three variables used as factors for fitting the models, being year, province and age.

For linear regression, we calculated mortality rates per 1000 population and transformed them by taking the natural logarithm. A constant was first added to avoid taking the logarithm of zero. After fitting the model, R-squares were obtained and used to assess goodness of fit. A value close to 1 indicates that the model is fit well. Additionally we use it as percentage in order to facilitate determination. For our linear models R-squares were 46.2 and 12.5 percent for males and females, respectively. This indicates that the model of accident mortality rate had poor fit.

Therefore Poisson models were then considered. We used number of deaths as the outcome variable with corresponding population per 1000 as an offset. After fitting the models, residual deviances were obtained. Residual deviances from male model and female model were 3214.1 and 2983.5 respectively with 2578 degree of freedoms in both models.

The adjusted mortality rates for each factor of interest is obtained by replacing the parameters corresponding to the other factors by a constant chosen to ensure that the total expected numbers of cases equals the observed numbers. Sum contrasts were used to obtain confidence intervals and we used these contrasts to create schematic maps of provinces according to their estimated road traffic accident mortality rates.

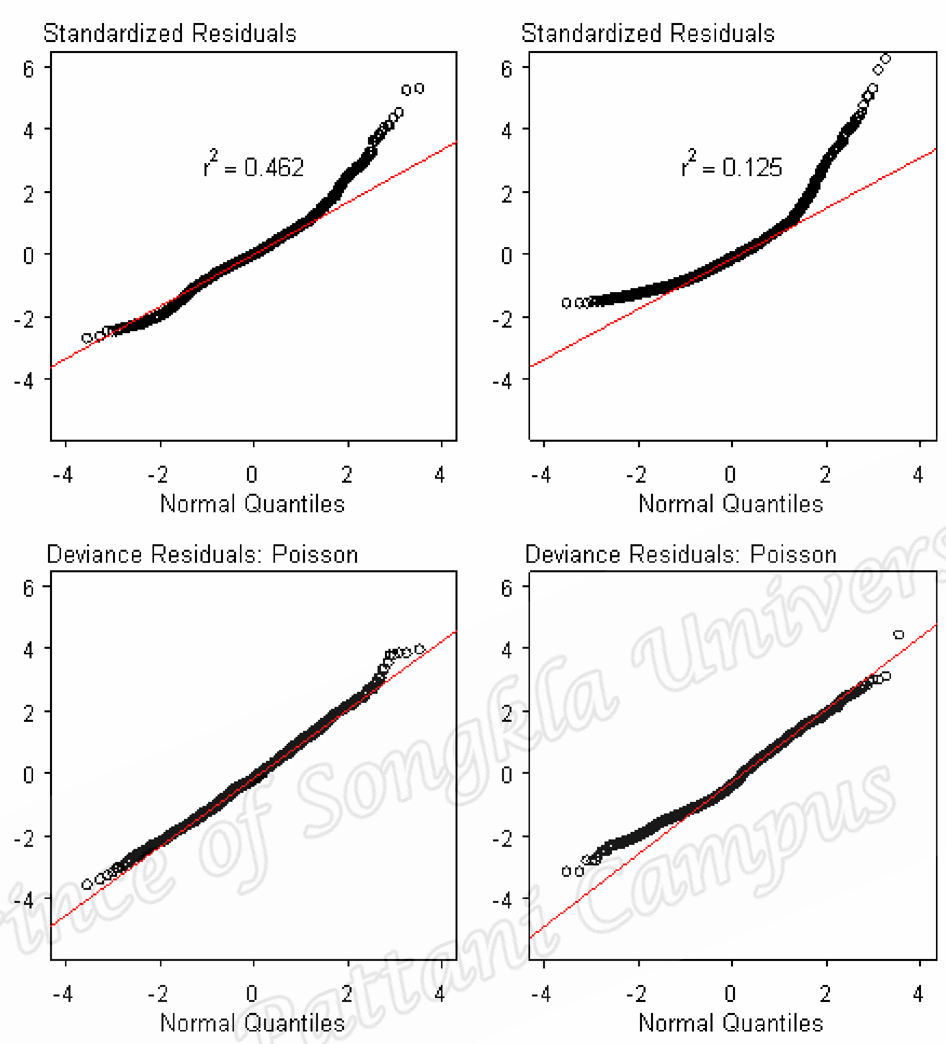

Figure 4.1 Diagnostic plots of linear models on top panels and Poisson models on bottom panels

Figure 4.1 shows plots of the residuals versus normal quantiles for both linear models (on the top panel) and Poisson models (on the bottom panel), left plots being for males and right plots being for females. It can be seen that linear models are unacceptable and Poisson models are more appropriate.

Figure 4.2 shows plots of observed counts and observed mortality rates per 1000 population versus corresponding fitted values obtained from Poisson models, left plots for male and right plots for female. As shown, it is reasonable to state that the models fit the data well.

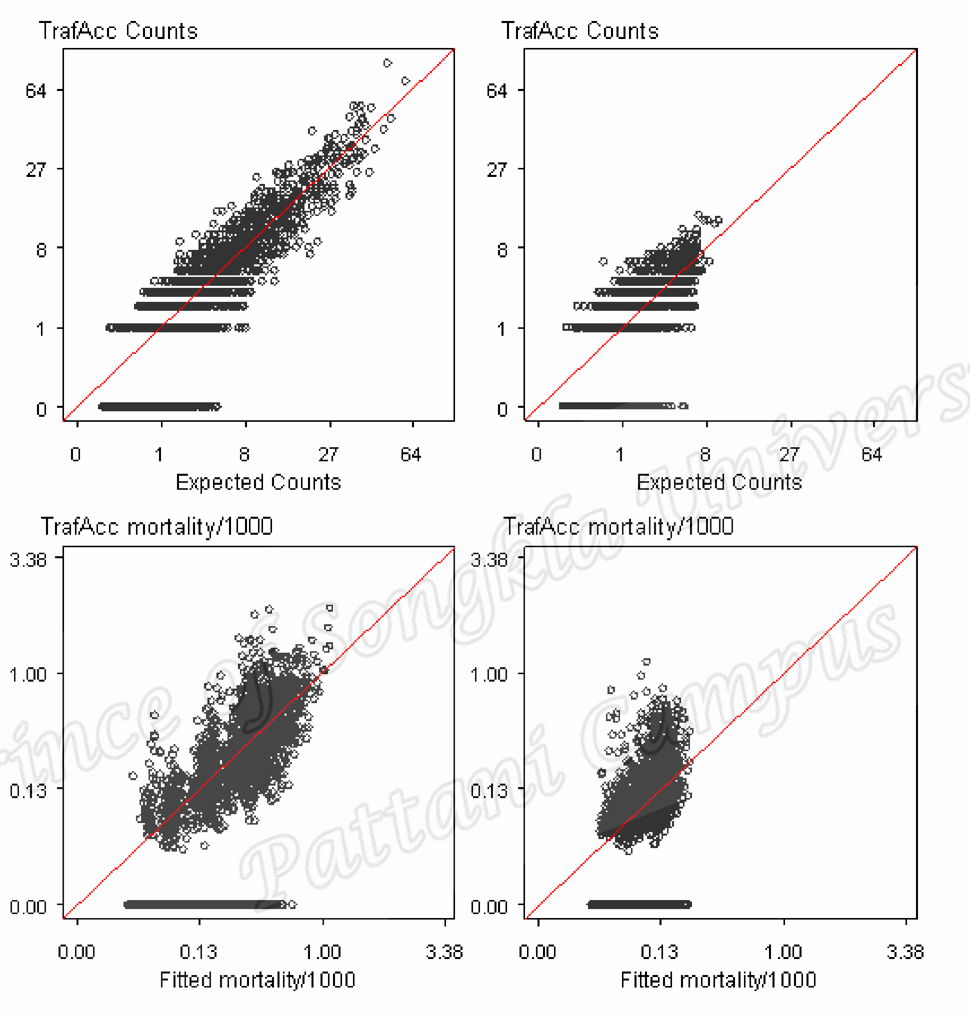

Figure 4.2 Plot of observed counts and observed mortality rates against fitted values

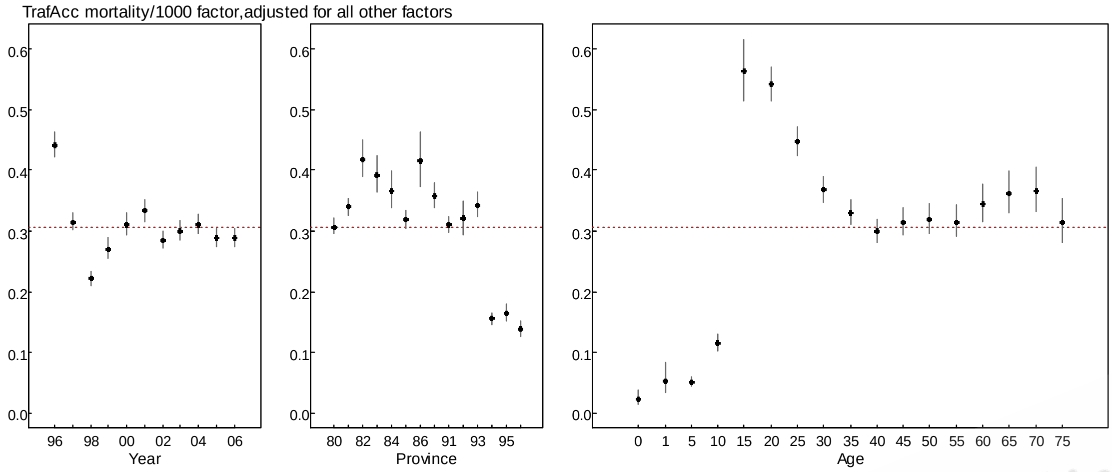

Figure 4.3 Male mortality rates/1000 by factor, adjusted for all other factors

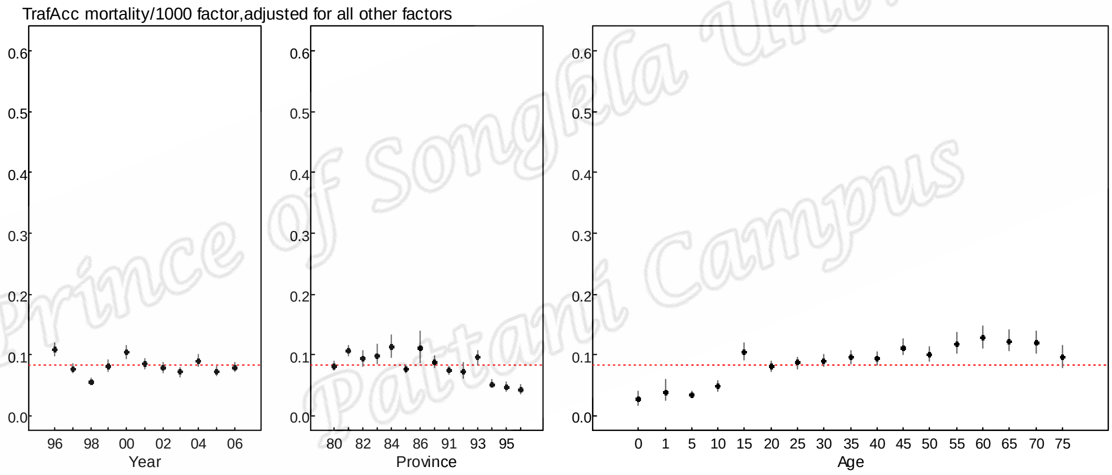

Figure 4.4 Female mortality rates/1000 by each factor, adjusted for all other factors

Figure 4.3 and 4.4 show 95% confidence intervals for road traffic accident mortality rates by year (left panel), province (middle panel) and age (right panel) each adjusted for the effects of the other factors in the model. The dotted horizontal lines on each graph represent the overall mean mortality rate (0.31 and 0.08 per 1000 population for males and females, respectively).

Males and females had the highest rate in 1996, the lowest rate both occurring in 1998. Phunga had the highest mortality rate for males and Surat Thani for females with rates being 0.42 and 0.11 per 1000 population respectively.

The lowest mortality rates among males were found in the youngest age group (0–9 years) and peaks markedly at age group 15-19 years with a rate of 0.56. Then mortality rates then gradually decrease until age groups 35-39.

Mortality rates among females age groups less than 9 years were the lowest. Afterward mortality rate increased rapidly at age group 10-14 year with a high at age group 15-19. Then mortality rate increased gradually from age 20 and peaked at age group 60-64 with rate about 0.13 per 1000 population.

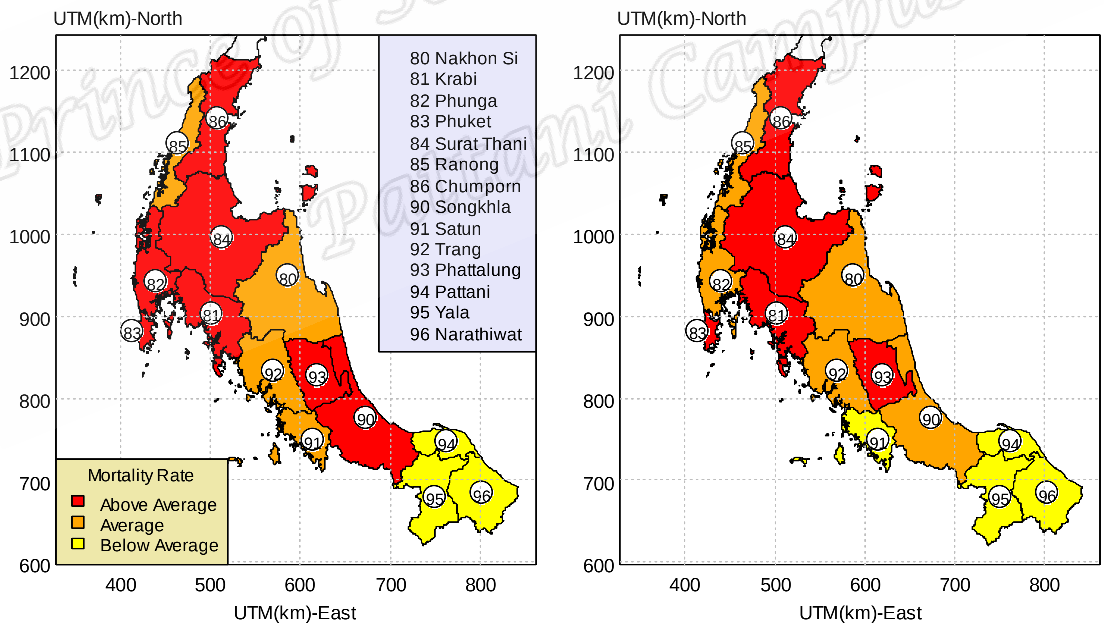

Figure 4.5 Schematic maps of road traffic accident mortality rate for males (left) and females (right)

Figure 4.5 shows schematic maps of the adjusted mortality rates per 1000 by province (left plot for males and right for females), base on confidence intervals shown in Figure 4.3 and 4.4. The maps show that, Chumporn, Surat Thani, Phuket, Krabi and Phattalung had mortality rates significantly higher than the mean in both genders, Phunga and Songkhla had significantly higher mortality rate than the mean for males but not for females.