Estimating Child Death from Perinatal Originating Conditions and Congenital Malformations in Thailand 1996-2009 based on the 2005 Verbal Autopsy Study

Binita Kumari Paudel, Nepal Institute of Health Sciences

Abstract: This study used child (aged under 5 years) deaths from the Thai 2005 Verbal Autopsy (VA) study to provide more accurate estimates of child deaths from perinatal originating conditions and congenital malformation than those reported. Different logistic regression models were fitted separately for these outcomes with province, sex and location of death (in or outside hospital) as factors. Total numbers of deaths from perinatal originating conditions and congenital malformations exceeded those reported by factors of 1.49 & 2.18, respectively. We used these results to estimate numbers of child deaths in Thailand for years 1996-2009.

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The 2005 Verbal Autopsy Study

About 40% of death certificates in Thailand give the cause of death as “ill-defined”, which severely limits their public utility. In contrast, less than 4% of deaths in Japan are ill-defined.

To address this problem, the MoPH proposes “to build capacity among Thai health professionals (physicians, paramedical staff, biostatisticians and epidemiologists) to critically assess vital statistics data and improve the quality of causes of death recorded at registration in Thailand.” (Rao et al 2010)

A verbal autopsy (VA) study was carried out in 2005 based on a sample of 3316 in-hospital and 6328 outside-hospital deaths from 28 selected districts in 9 provinces (Rao et al 2010, Pattaraarchachai et al 2010, Polprasert et al 2010, Porapakkham et al 2010). However, Byass (2010) concluded that uncertainties remain.

The VA study assessed cause of death from a sample of **9644** cases, giving a data table with 5 fields:

(a) the deceased person's **province**: the 9 with sample sizes shown;

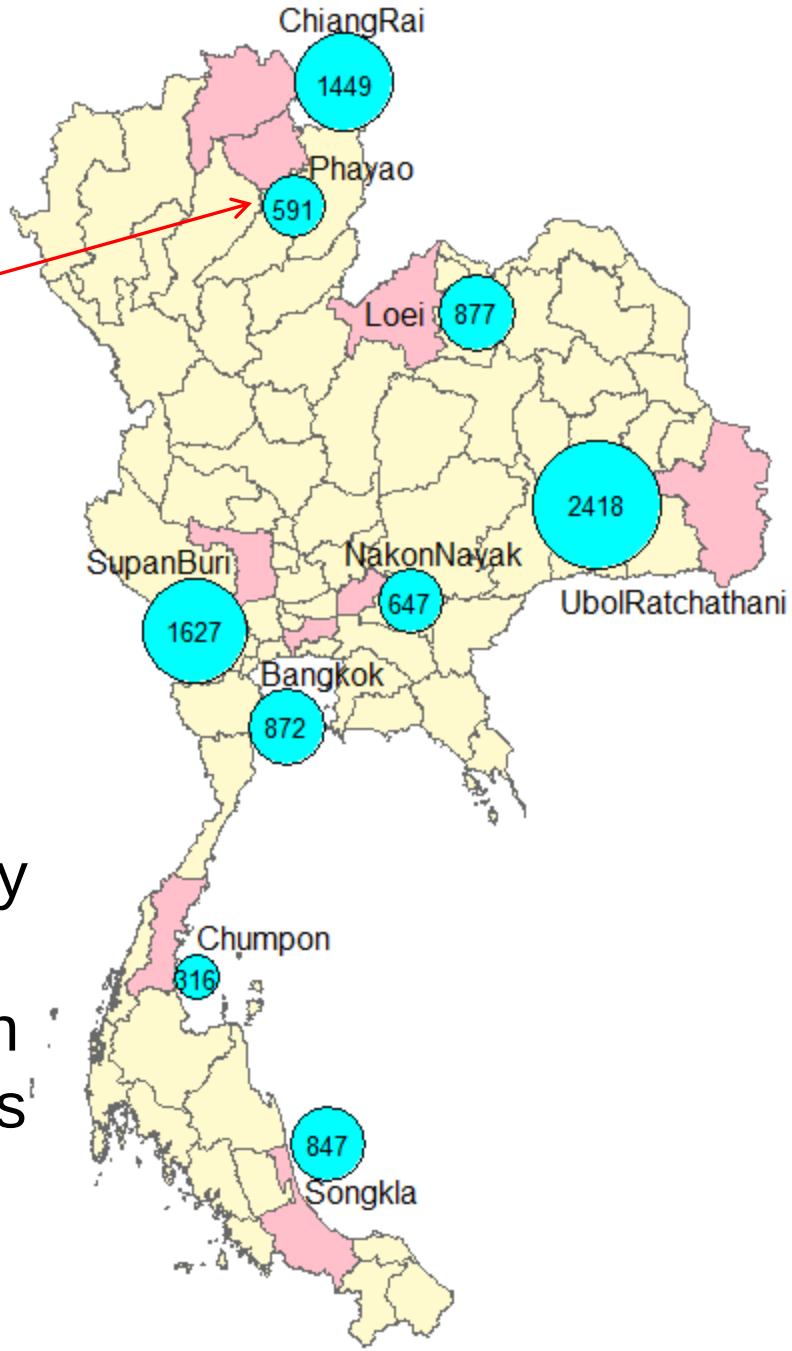
(b) the person's **gender** and **age**;

(c) the **ICD-10 code reported** on the death certificate;

(d) the **location of death** (in hospital or outside hospital);

(e) the **VA-assessed ICD-10 code**.

The VA study team separated results by field (d), grouped fields (c) and (e) into the 20 leading causes of death for each location, and thus found inflation factors for determining percentages of deaths in specific cause groups.



Under 5 Deaths in VA Study

Cause group	*0-4 years*	*5+ years*	Total
Perinatal (ICD-10 block P)	59	0	59
Congenital (ICD-10 block Q)	38	16	54
Other causes	52	9479	9531
Total	149	9495	9644

Note that all deaths due to perinatal originating conditions and more than two-thirds of deaths from congenital malformations were aged under 5, whereas almost all deaths from other causes were aged at least 5 years.

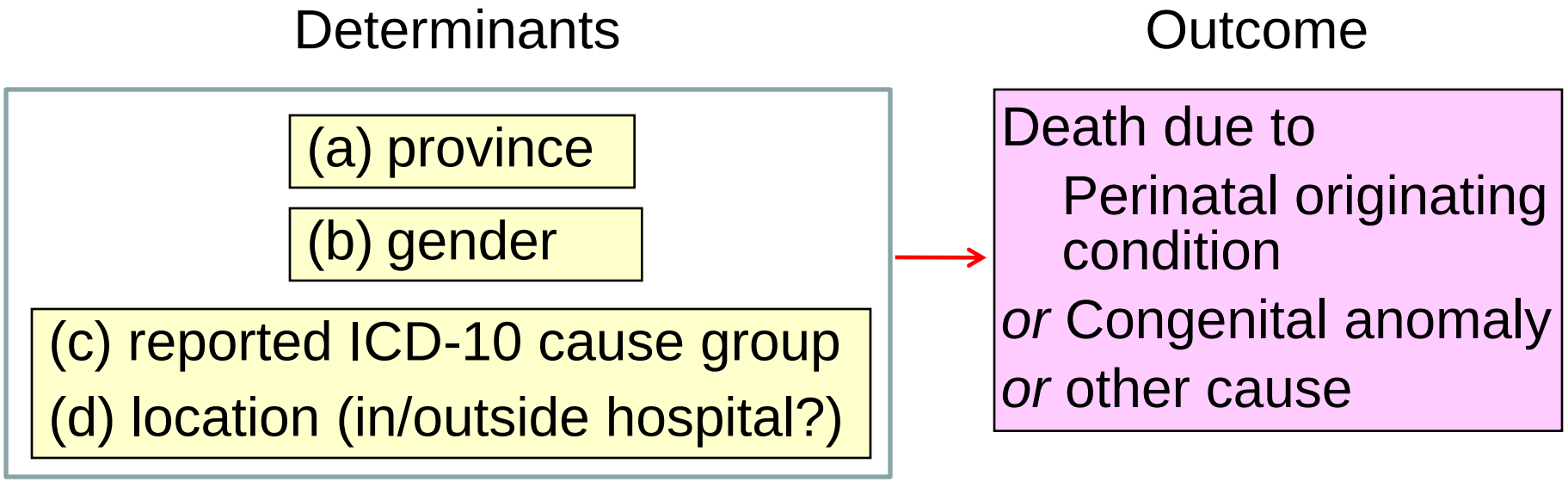
Since our overall objective was to allocate causes of death to their correct ICD chapter-block groups, we did this separately for child (under-5 year) deaths and deaths aged 5 or more years.

Path diagram for analyzing child deaths

Target population: All reported Thai deaths of under 5 years, Jan 1996 - Dec 2009.

Sample: Subset of deaths under 5 years (149 from total of 9964) in 2005 VA study.

Outcomes: Deaths from perinatal originating conditions, congenital malformations and other causes.



Determinants separate naturally into regional, demographic, and medical components.

Analysis method

Since the outcome is a nominal variable with three levels, the appropriate model for systematic analysis of death by ICD10 code is **multinomial regression**.

However, it is simpler and more informative to separately fit **logistic regression** models to the three outcome cause groups, and then **rescale** the results to ensure that the total numbers of deaths estimated for each group match those reported in the corresponding populations.

This method also gives **confidence intervals** for percentages of deaths in cause groups for levels of each risk factor adjusted for other risk factors, using methods developed by Tongkumchum & McNeil (2009) and Kongchouy & Sampantarak (2010). These confidence intervals are compared with **bar charts** of sample percentages to assess evidence of confounding bias.

Area plots are used to show results by gender & year.

Logistic regression model

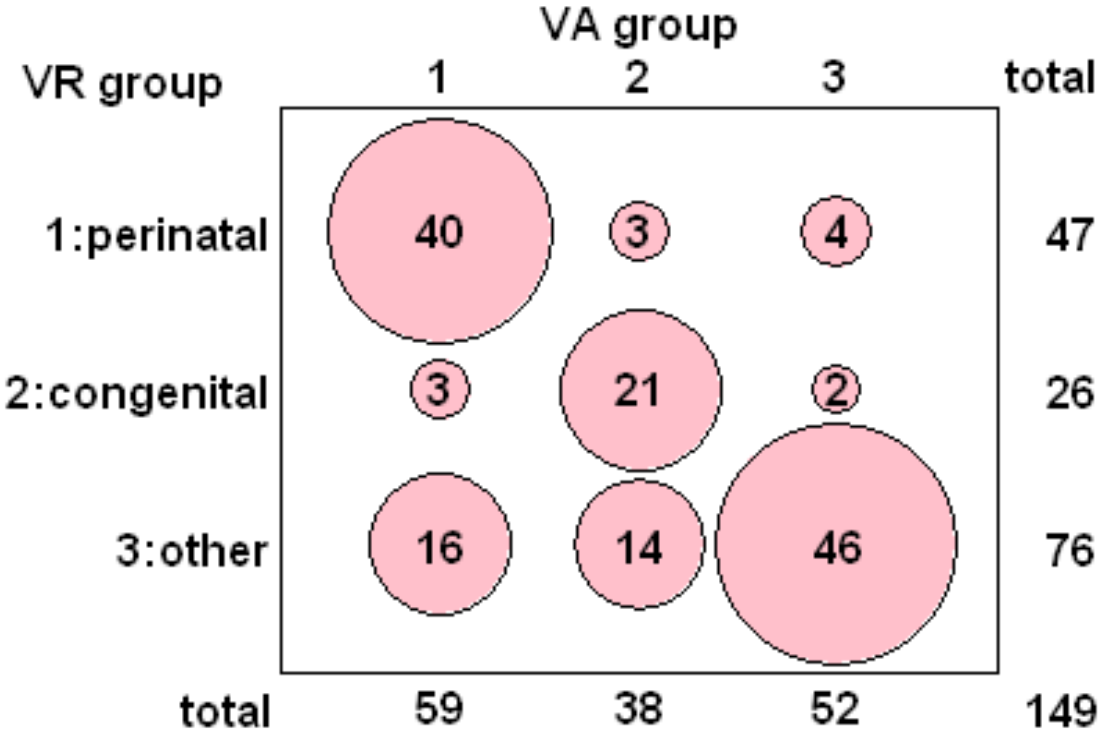
This model formulates the logit of the probability ***P*** that a person died from the selected cause as an additive linear function of the three determinants (***study factors***) as follows:

$$\text{logit}(P) = \log(P) - \log(1-P)$$
$$= \text{constant} + \text{factor}(\textbf{province}) + \text{factor}(\textbf{gender}) + \text{factor}(\textbf{VR cause-location group})$$

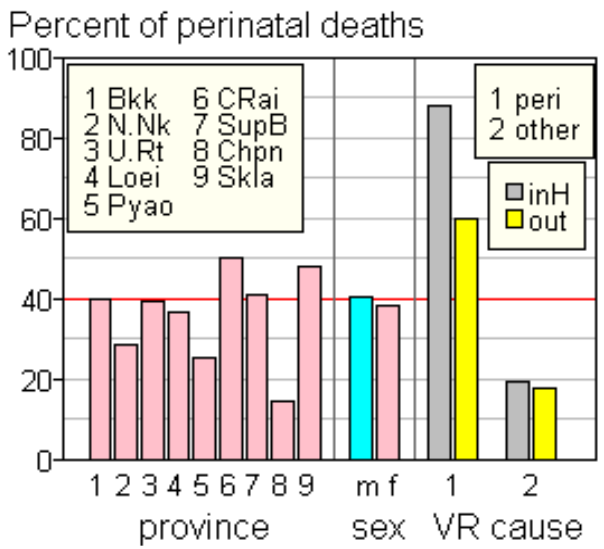
The **province** factor has nine levels comprising each province in the VA sample. For the prediction of death from specific causes, we define **VR cause-location group** comprising the VR cause group and location of death (in or outside hospital). We created only two cause groups where one group is the cause of interest and the other group aggregates deaths from all other causes. Therefore, **VR cause-location group** has four levels.

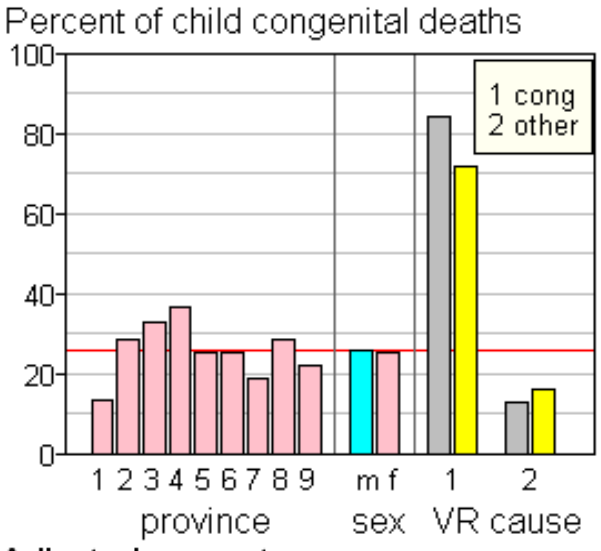
Results

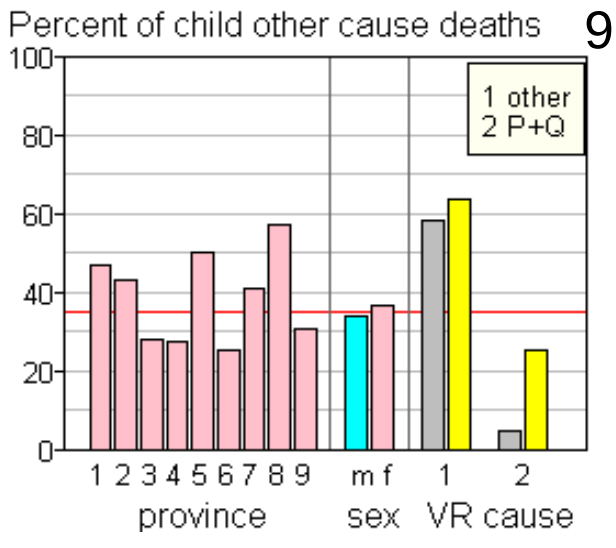
The VA and VR cause groups are positively associated, as expected, with both perinatal and congenital deaths under-represented, and other child deaths over-represented.

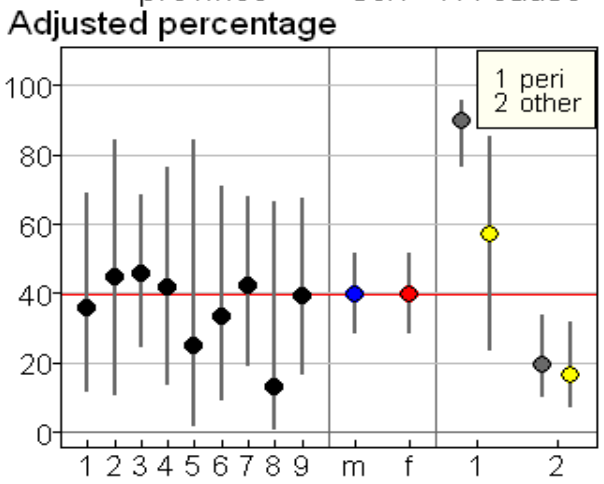


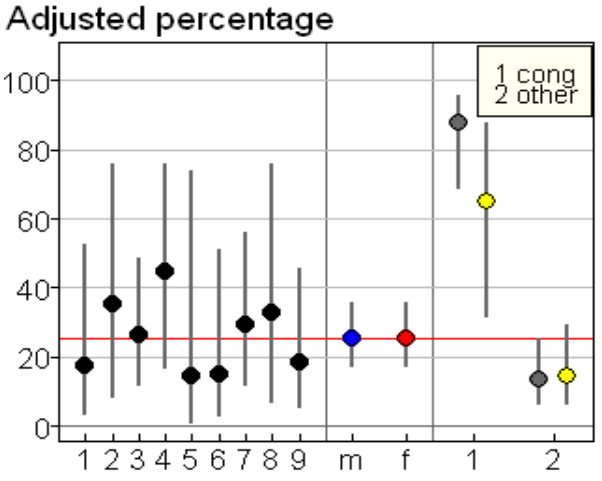
The next slide shows bar charts and plots of corresponding adjusted confidence intervals of percentages, and p-values for assessing effects of study factors after fitting the models.

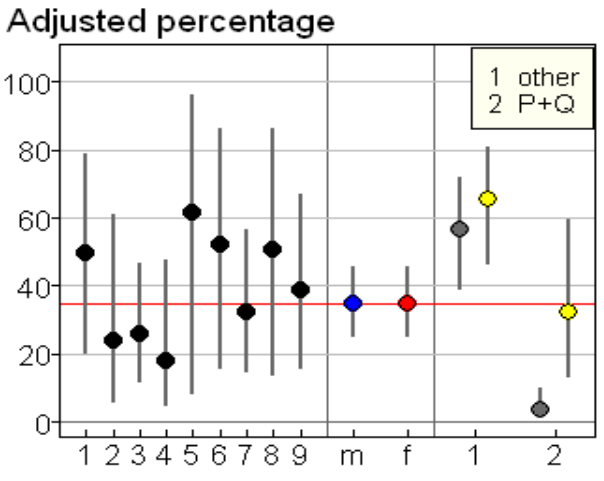












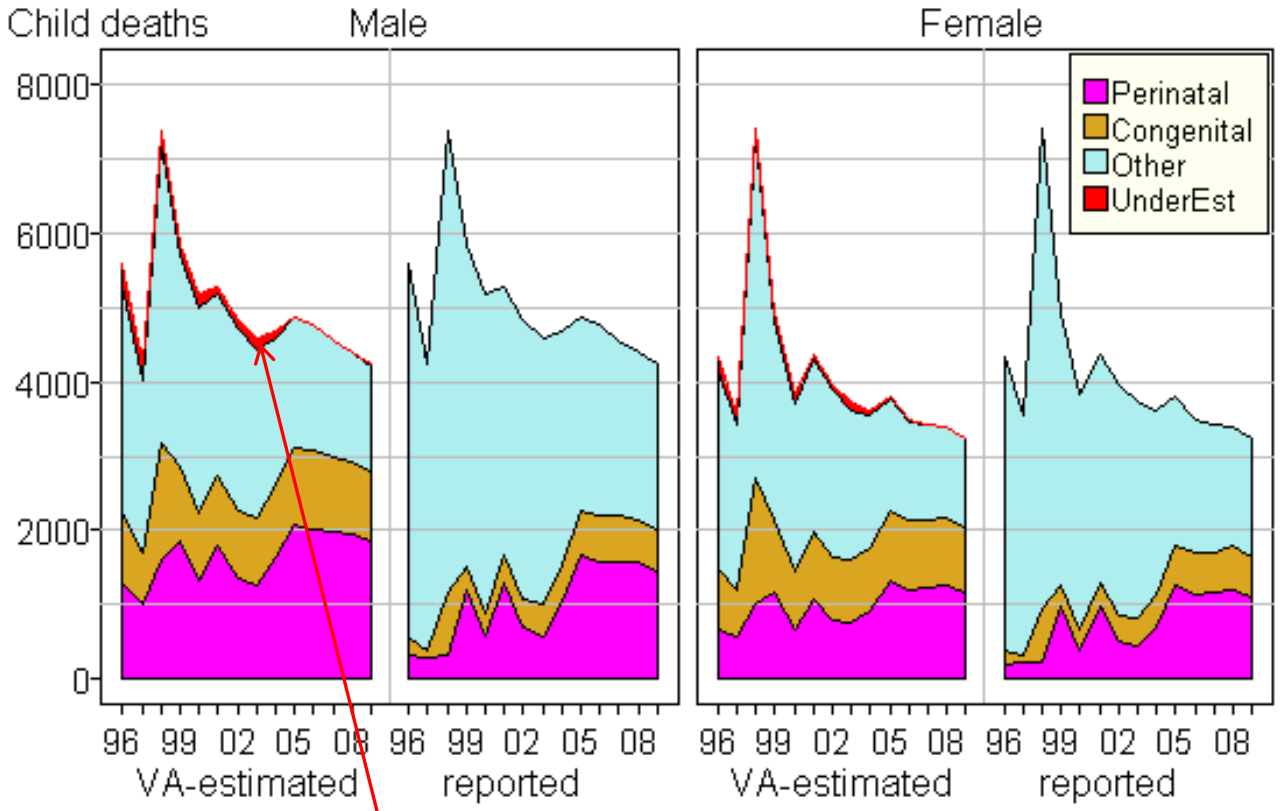
P-values based on Logistic Regression Model

Study factor	Perinatal	Congenital	Other
Province	0.978	0.936	0.774
Sex	0.238	0.704	0.515
VR cause	<0.00001	<0.00001	<0.00001

Extension to the target population

An area plot shows numbers of reported child deaths in the target population for years 1996-2009 after adjusting for misreporting based on the models.

The models do not ensure that adjusted death counts in each year match reported totals, because they aggregate results from separate logistic regression models.



Discrepancies are shown as red-coloured areas in the above plots. A **multinomial** model ensures that adjusted and reported totals match, but simply scaling totals from separate models gives similar results.

Conclusions

The study found:

- total numbers of estimated child deaths from perinatal originating conditions (36,838) and from congenital malformations (26,806) were respectively 1.49 and 2.18 times higher than those reported for these cause groups (24,770 and 12,277). As a consequence, deaths from other causes (mainly injuries and other external causes) were over-reported.
- no evidence of a difference in the proportions of deaths in these cause groups by gender or province.
- statistically significant differences in the proportions of deaths in these cause groups by reported cause and location in or outside hospital. As would be expected, deaths reported from perinatal originating conditions and congenital malformations in hospital were highly likely to have been correctly reported (as the confidence intervals on slide 9 clearly show).

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