Chapter 4

Discussion and Conclusions

4.1 Summary of overall findings

For missing demographic variables from 1996-2009, unknown province mostly occurred in the youngest age group of 0-4 years and the working age group of 15-44 years whereas unknown age mostly occurred in the provinces of the central and the southern regions. The percentages of unknown province were high in 2000-2004 (2%-7%) and reduced to 0.01% in 2009. The unknown age steadily reduced from 4.8% in 1996 to 0.05% in 2009. All these indicated improvement of quality of DR data. Overall deaths were high between aged 20 and 30 years in the early phase (1996) in the northern part. This was less pronounced overtime.

From VA-assessed, HIV deaths were common in age group 20-39 years and more likely in female young adults. These deaths were frequently classified in DR as death from TB or from mental and nervous system disorders. Under-reporting in DR was most common in the upper north and the upper south of the country in the working age groups. VA-assessed HIV deaths gave results exceeding DR data by a factor of 3.09. In other words, DR data account for only one third of all VA-estimated HIV deaths.

4.2 Discussion

Reasons for the absence of demographic details on death certificates could be due to persons dying away from relatives and without ID cards. The age distribution of

deaths with an unknown province of residence mostly occurred in the working groups, suggesting that many such cases could be due to injuries occurring outside the province of residence or migration. The number of deaths with unknown province increased from 1996 to 2004, possibly partially due to migration because deaths outside residence increased from 2.9% in 1996 to 11.1% in 2009 (Vapattanawong and Saplon, 2011). Thus, it would be informative to investigate such cases further.

Unknown-age above average mainly occurred in the central region. Our findings correspond to deaths outside residence mostly occurred in Bangkok and the central region. Furthermore, deaths outside residence mostly occurred in the working age group of 15-49 years that correspond to the same age groups of deaths with unknown province. However, deaths with unknown age are higher among females whereas deaths outside residence are higher in males (Vapattanawong and Saplon, 2011). It needs further analysis.

Since death certificates in Thailand also provides information of the deceased person's age, sex and district (available from the Ministry of Interior), it is possible that further accuracy could be gained by using the 926 districts into which the nation is divided, rather than the 76 provinces. Faramnuayphol *et al*. (2008) used district as the location factor in their regional comparison of cause-specific mortality, and Odton *et al*. (2010b) used 235 aggregated districts with similar populations in their study of regional variation of age-group and sex-adjusted all-cause mortality. However, neither of these studies made adjustments for deaths reported with unknown region or age. Although in a subsequent study, Odton *et al*. (2010a) investigated regional variations in deaths reported with unknown cause, correcting for unknown cause in mortality

data is essentially a different problem, because in this case there is no cause-specific population denominator.

The full model for predicting HIV shows sensitivity, specificity, and AUC, better than the simple cross-referencing model. The specificity level from our model was higher than a verbal autopsy tool from Uganda, where sensitivity was not reported (Mayanja *et al*., 2011). The cross-referencing method has been used in many previous studies (Taffa *et al*., 2009; Choprapawon *et al*., 2005; Polprasert *et al*., 2010; Pattaraarchachai *et al*., 2010; Porapakkham *et al*., 2010; Mayanja *et al*., 2011). Inadequate models can give misleading or incorrect inferences (Sakar and Midi, 2010). Our study showed that the use of this simple method should be discouraged because it distorts the HIV death estimate in various demographic groups. This distortion can mislead priority setting and resource allocation. Several studies have used logistic regression method to correct missing data or handling misclassification of binary outcome (Duffy *et al*., 2004; Li *et al*., 2004; Lyles *et al*., 2011). In addition, model-based methods are more promised to dealing with missing data when compared to ad hoc methods (Pigott, 2001).

HIV deaths were found to be relatively common among deaths in the age group 20-39 years, in agreement with other studies (Yudkin *et al*.,2009; Punyacharoensin and Viwatwongkasem, 2009). AIDS is estimated to be the largest causes of death in Asian adults 15-44 years (Kerr and Phanuphak, 2009). Sex and residential area were found significantly affected mortality among HIV/AIDS patients in the southern region (Woradet *et al*., 2012). In high risk age groups (20-39 years), we found that percentages of HIV deaths more severe for females that implied more

misclassification in this sex and age range. This is possibly HIV infection groups have changed over this period in Thailand. Before 1990, new HIV infections were highest among those injecting drugs and clients of sex workers. During 1995-2005, they were highest among the women with the category of housewife (The Thai Working Group on HIV/AIDS Projections (2005), 2008). In other words, the most under-reporting of HIV deaths was found in females rather than males.

Most misclassifications of HIV deaths were classified as TB or mental and nervous system disorders. It is commonly known that TB and cryptococcal meningitis are the leading causes of opportunistic infections among HIV patients (Kantipong *et al*., 2012; Cain *et al*., 2009; Kitkungvan *et al*., 2008; Likittanasombut, 2004). These infections were possibly recorded as the primary causes of death in death certificates to avoid stigma to the family of the deceased, because the symptoms of TB and HIV are very similar, or because the people reporting the death might not have access to the results of a HIV test for the deceased. Another general condition often recorded was "immunodeficiency (D849: immunodeficiency, unspecified)". This might in fact be the more specific "HIV/AIDS (B20-B24: Human immunodeficiency virus disease)" in ICD-10 coding (Khonhan, 2009).

HIV mortality peaked in the upper north, especially in Phayao, because in the past two decades the HIV epidemic has been most severe in the upper north (Punyacharoensin and Viwatwongkasem, 2009; The Thai Working Group on HIV/AIDS Projections 2005, 2008; Surasiengsunk *et al*., 1998; Bureau of epidemiology, 2013; Chariyalertsak *et al*., 2001; Jones and Pardthaisong, 2000). Projection by Surasiengsunk *et al*. (1998), one-third of HIV deaths were predicted in

the northern region since 1987-2014. Those HIV deaths were higher in the upper South than in the Central region in spite of the less severe HIV epidemic (Bureau of epidemiology, 2013). HIV deaths in the South were more likely to be misclassified to other causes, as the area was perceived to have low levels of HIV (Faramnuayphol *et al*., 2008). In addition, mortality varies by geographic location and the South has the lowest overall mortality (Faramnuayphol *et al*., 2008; Odton *et al*., 2010b).

This study shows DR-reporting of HIV deaths from 1996-2009 account for only one third of all VA-estimated HIV deaths. Our VA-estimated HIV deaths underestimated when compared with the AEM projections by the Thai Working Group on HIV/AIDS (2008) in the same periods. The projection exceeded the DR-reported deaths by a factor of 5 whereas our model exceeded the DR-reported deaths by a factor of 3.09. This difference may be due to reporting of HIV deaths changed over the period 1996-2005, and the VA study in 2005 could not take account of this change, particularly for years before 2005 when reporting practices were distorted by the HIV epidemic (Hill *et al*., 2007; Surasiengsunk *et al*., 1998). Im-em (2013) reported that only 30% of HIV deaths were reported in DR. This implied AEM projection might be an over estimate because it used several epidemiological and behavioral data sources and projection accuracy depends on data quality.

Porapakkham (2010) estimated HIV deaths in 2005 with results exceeding DR data by a factor of 4.13 whereas our model gave results exceeding DR data by a factor of 2.8 in that year. This result is different because they estimated proportions of deaths without using statistical modeling. The adjusted proportionate without model-based

cannot be adjusted confounding factors. This can lead to distort the estimation in sex, age groups and province.

However, the AEM projection of HIV deaths and HIV estimated deaths by Porapakkham et al. (2010) cannot be compared directly with HIV estimates in this study because the assumptions, methodologies and data used to produce the estimates are qualitatively different.

4.3 Conclusions

Missing data and misclassification causes of death can be handled using logistic regression model. Inadequate models can give misleading or incorrect inferences. The causes of approximately two thirds of all HIV deaths estimated by the full model were reported under other categories but HIV. This implied that the HIV epidemic which was stigmatizing might have been tremendously unreported or reported as other causes of death, especially among the migration young adult. Our results illustrated under-reporting/misclassification of HIV deaths varying by sex, age group and location. This indicates that demographic factors are important for correcting causes of death.

4.4 Limitations

The limitations of the second Part and the third Part (B) need to be kept in mind. There are five main grounds for claiming inefficiency of the 2005 VA study. First, the sample survey design did not stratify by strong predictors of the outcome such as reported cause and location inside or outside hospital. Instead, only the total number of deaths was used, and this is a relatively weak predictor of causes of death.

Second, the 2005 VA study used a design that may not have effectively covered the population at risk. For example, no Muslim-majority districts were included in the sample, even though Muslims comprise more than 5% of the Thai population.

Third, the VA study had sample sizes varying from 316 in Chumphon to 2,418 in Ubon Ratchathani. This variation arose because simple random sampling (SRS) was used at the final stage that the samples were allocated in proportion to the population. This is not quite the same as probability-proportional-to-size (PPS) sampling (Lumley, 2010). This method gives sample sizes that vary in proportion to the populations of the regions. The accuracy of an estimate obtained by random sampling depends mainly on the size of the sample and not the size of the population. Unless the populations of the regions are of similar size, proportional allocation can give rise to small samples with relatively large standard errors and resulting loss of accuracy. Instead, it might be better to balance sample sizes across regions.

Fourth, we have assumed that the 2005 VA data can inform corrections in all years between 1996 and 2009, while it is clear that the coverage of antiretroviral therapy (ART) was near zero in 1996, 12% in 2003, 41% in 2005, and 76% in 2009. ART coverage levels may be related to differences in misclassification of HIV-related deaths that are not captured by our methods. Resulting estimates could have been different had the 2005 VA study been conducted in 1996 (when ART programs just started) or 2009 (when ART coverage was higher compared to 2005) (National AIDS committee, 2013).

Finally, we have considered the 2005 VA study as a gold standard reference, while it is clear that VA methods have their own biases and uncertainty, e.g. due to the

similarity in signs and symptoms between TB and HIV, recall information bias in the response interviews as well as potential for inconsistency of interviewer. In addition, the model used in our study contains province as a determinant factor, but only nine of Thailand's 76 provinces were included in the VA study. Thus, the estimations must be interpreted with caution.

4.5 Recommendations

Logistic regression method is straightforward, provides confidence intervals, and can be generally used for eliminating biases due to cases with unknown values of demographic factors in DR data and correcting under-reporting/misclassifications of HIV deaths based on the 2005 VA data including triangulation method. Our methods have the potential to add value to VA data, save costs of conducting VA surveys in other developing countries and enhance performance of health personnel in research.

However, this study limits its focus on a single causes of death ie HIV. There are other deceased that are also misclassified. Logistic regression may be inadequate to solve multiple misclassification problems.

Results from this study will provide useful information for the Ministry of Public Health in Thailand. DR data quality should be improved by carrying out capacity building in the regions that missing values including misclassification causes of death were presented with the full cooperation of the Ministry of Public Health and the Ministry of Interior. Furthermore, dissemination of results will also useful for further studies. Researchers can apply these methods to other multidisciplinary data such as education, geographical etc.

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