Chapter 1

Introduction

1.1 Background and rationale

Child under-five mortality is an important measure of health and development. In terms of how importance it is highly regarded, reports are produced by UNICEF, WHO, UN population Division, and the World Bank annually. Sound measurements are needed not only at national level but also at micro level, so that we can learn from successful areas and identify areas where extra efforts are needed to accelerate declining rate of under-five mortality.

However, the absence of complete deaths registration (DR) and misclassification of cause of deaths are key factors to difficulty in determining the true distribution of under-five deaths by cause especially in developing countries including Thailand. Death certificates in Thailand classified 35-40% of the cause of death as ill-defined, which severely limits their utility. Therefore, the DR data were judged as low quality (Mathers *et al*, 2005) and a more credible method is needed for estimating specific cause of deaths.

This study aims to analyze under-five mortality data from the DR database in Thailand from 2000 to 2009 using appropriate statistical methods and to identify public health areas (PHA) where under-five mortality rates are still high. Since most of deaths for under-five were due to perinatal originating conditions. The under-five deaths from perinatal originating conditions is also investigated after estimating the number of death by cause based on analysis of verbal autopsy (VA) data in 2005.

1.2 Objectives

The objectives of this study are as follows.

1. To describe the distribution of all-cause and perinatal originating conditions mortality rates for children under-five years in Thailand.
2. To analyze the trend of all-cause and perinatal originating conditions mortality rates for children under-five years by gender and public health area in Thailand.
3. To develop a statistical model for estimating all-cause and perinatal originating conditions mortality rates for children under-five years in Thailand.

1.3 Expected advantages

1. The death rates for children under-five years in Thailand will be clearly revealed to be more simply comprehensible by using graphical methods and maps.
2. The information from the rates will provide a useful insight on death for children under-five years in each year and demographic factors.
3. The findings of this study will be useful for health planning to reduce death rates of children under-five years.

1.4 Definition of perinatal originating conditions

Perinatal originating conditions definition includes fetal deaths of 28 weeks or more gestation and infant deaths of less than 7 days of age (WHO, 2006).

1.5 Literature reviews

Thai death registration data

Thai death registration system has evolved since it was established a century ago. A collection of mortality statistics has been much improved since 1996, when the civil registration system of Ministry of Interior (MOI) has provided electronic death data directly to the death statistics management process of the Ministry of Public Health (MOPH).

Although, the records of deaths are accurately collected with this collaborative system, Thailand is still challenged with the quality of cause of death (COD) information. The online system has been nation-widely established and provides a timely mortality databases transferring from the MOI to the MOPH. The completeness is reasonably well accepted for the early infant deaths (Kijsanayotin, 2011).

The major gaps of this system are the remaining high proportion of ill-defined and misclassified COD. The accuracy of the COD was compromised, because 60-70% of the deaths occurred outside hospitals and were classified as natural COD by head of the village and civil registration officers, who virtually had no medical background. Moreover, the coding COD competency among physicians and health professionals still needs improvement (Kijsanayotin, 2011). Several studies have been concerned with the quality of mortality data from the registration system in Thailand (see, for example, Prasartkul and Vapattanawong, 2006; Tangcharoensathien *et al*, 2006; Mathers *et al*, 2005). The MOPH has been working on these challenges in many ways including an introduction to a verbal autopsy (VA) study in 2005 (Rao *et al*, 2010;

Pattaraarchachai *et al*, 2010; Polprasert *et al*, 2010; Porapakkham *et al*, 2010). The VA data can be used as a supplement source to estimate number of deaths by cause in the DR database.

Moreover, due to the country universal health care coverage, which has been implemented since the national health insurance act was promulgated in 2001, the insurance reimbursement administrative data of the majority of in-hospital patients, which contain standard coded diseases data and status at discharge, are now available. The data are being used to enhance the quality of country vital statistics (Kijsanayotin, 2011).

The quality of death registration

The quality of death registration is a main problem especially in developing countries. At the end of 2003, data on death registration were available from 115 countries, although they were essentially completed for only 64 countries. There were 23 countries having data of over than 90% completion, where ill-defined causes were accounted for less than 10% of total of causes of death. There were 28 countries where less than 70% of the data were complete, or where ill-defined codes were assigned to more than 20% of deaths (Mathers *et al*, 2005).

In Thailand, the completeness of death registration in 1996 was 94.8% (Prasartkul and Vapattanawong, 2006), while deaths from ill-defined in 2005 were reported for 40% of the total (Polprasert and Porapkkham, 2005). Thailand was one of the 115 countries that provided death data to WHO, but mortality statistics in Thailand were classified as low quality, with over 30% of deaths unregistered and more than 20% of those registered classified as ill-defined cause (Mathers *et al* (2005). Rukumnuaykit (2006)

suggested that the users were able to take major causes of death into account for their analysis or larger grouping data allowed the analyses more consistent and less prone to possible errors.

Under-five mortality statistics

Global statistics, since 1990 the under-five mortality rate has dropped 41% from 87 deaths per 1,000 live births in 1990 to 51 in 2011 (UNICEF, 2012).

In Thailand, the under-five mortality rates per 1,000 live births were 58 in 1980, declining to 30 in 1990 and to 23 in 2000 (Hill et al, 2007). The annual under-five mortality rates per 1,000 live births from 2007 to 2011 in Thailand were 10.0, 9.9, 9.8, 9.8 and 9.0, respectively (Ministry of Public Health, 2012).

Vapattanwong (2009) reported provincial disparities of under-five mortality using the data from Thailand Multiple Indicator Cluster Survey. The indirect estimation of child mortality using Trussell version of Brass indirect method was applied to the data. The under-five mortality rates of 24 from 26 sample provinces were in the range of 4.8-37.1 per 1,000 live births. The lowest under-five mortality rate was found in Ratchaburi Province, while the highest under-five mortality rate was found in Narathiwat Province.

Under-five mortality trends

The trends in the under-five mortality rate have been globally decreasing from 1990, 1995, 2000, 2005 to 2010. In 1990, the under-five mortality rate decreased from 87 deaths per 1,000 live births to 82, 73, 63, and 53, respectively. In 2011, the under-five mortality was 51 deaths per 1,000 live births. In the developed regions, the under-five mortality rate decrease from 15 deaths per 1,000 live births in 1990 to 11, 10, 8, and

7, respectively. In 2011, the under-five mortality was 7 deaths per 1,000 live births. In 1990, the under-five mortality rate in the developing regions decreases from 97 deaths per 1,000 live births to 91, 80, 69, and 59, respectively. In 2011, the under-five mortality rate was 57 deaths per 1,000 live births (UNICEF 2010; UNICEF 2011; UNICEF, 2012).

Causes of deaths for children under five years

Estimates of under-five deaths by cause are important for targeting interventions to reduce child mortality and to its monitor progress. Although the total number of under-five deaths is relatively well known, the proportion related to each cause is much more uncertain. There are several reasons for this. First, vital registration systems that provide cause-of-death data do not exist in most developing countries. Second, children often die from multiple causes, and to decide which the primary cause is difficult. In addition, malnutrition is associated with half of all deaths. Small-scale studies were also used to estimate the cause for the majority of under-five deaths (UNICEF, 2012).

However, there are some previous reports on under-five causes of death. Out of 7.6 million deaths for children younger than five years in 2010, the causes of deaths mostly were pneumonia (14.1%, 1.071 million), diarrhea (9.9%, 0.751 million), and malaria (7.4%, 0.564 million) (Liu *et al*, 2012).

Black *et al*. (2010) reported a systematic analysis on global, regional, and national causes of child mortality in 2008. Among 8.795 million children younger than five years deaths worldwide, the main cause of deaths was infectious diseases (68%, 5.970

million), with the largest percentages being from pneumonia (18%, 1.575 million), diarrhea (15%, 1.336 million), and malaria (8%, 0.732 million).

In 2000-2003, six causes accounted for 73% of the 10.6 million yearly deaths in children younger than age five years worldwide: 19% was pneumonia, 18% was diarrhea, 8% was malaria, 10% was neonatal pneumonia or sepsis, 10% was preterm delivery, and 8% was asphyxia at birth (Bryce *et al*, 2005).

Morris *et al*. (2003) predicted the distribution of under-five deaths by cause in countries without adequate vital registration systems. The predicted distributions of deaths by cause in sub-Saharan reveal that 23% was pneumonia, 24% was malaria, 22% was diarrhea, 29% was neonatal and other, and 2% was measles. In South Asia, the predicted distributions of deaths by cause show that 23% was pneumonia, <1% was malaria, 23% was diarrhea, 52% was neonatal and other, and 1% was measles.

Rudan *et al*. (2010) reported causes of deaths in children younger than five years of age in China in 2008. The leading causes of deaths were pneumonia, birth asphyxia, and preterm birth complications, each accounting for 15-17% of all deaths. The followy causes were congenital diseases (11%), accidents (10%), and sudden infant death syndrome (5%).

Udomkitti (2011) reported high risk factors of pregnant women related to perinatal death in Pra Nakhon Si Ayutthaya hospital. The result found that the risk factors were from pregnant women (religion, education, location, and curing rights), obstetrical history (gravidity, parity, and number of ANC from ANC aid), intarpartum care (anemia, heart disease, chronic hypertension, premature ruptured of membrane, and

post term deliveries), and neonate (birth weight, fetal abnormalities, and number of fetal movement before birth).

Prasunnakarn (1997) reported perinatal mortality in Udonthani Province in 1996. There were 25,273 births with a total of 286 (1.1%) perinatal deaths. The perinatal mortality rate was 11.3 per 1,000 live births. The main cause of death was macerated stillbirths which accounted for 29.7%. Other causes of death were prematurity (28.4%), asphyxia (18.5), congenital malformation (13.6%), and some specific conditions (9.8%). Factors significantly associated with perinatal death and listed according to their strength of association were low birthweight, complications during pregnancy, complications during labor, non-vertex presentation, parity ≥ 4, preterm labor, birthweight $\leq 3{,}500$ g., and weight gain during pregnancy < 10 kg.

Statistical models for analyzing under-five mortality data

One of the most popular mortality models is the Lee-Carter (LC) model, proposed by Lee and Carter (1992). It has been applied to mortality data in many countries to estimate and forecast mortality rates, for example Australia (Booth *et al*, 2002) and the seven most economically developed countries (G7) (Tuljapurkar *et al*, 2000).

de Mateo and Regidor (1996) compared the conventional technique of stratified analysis with Poisson regression to estimate a standardized mortality rate and to evaluate the speed of the two techniques in making the calculation. In stratified analysis a single estimate for each year was obtained, whereas the model of Poisson regression that best fitted the data included an interaction term between age and year.

Linear regression was used by Kindig *et al*. (2002) to examine the factors associated with age-adjusted death rates in 366 metropolitan and non-metropolitan areas of the

United States for 1990-1992. They found that analysis explained 71% of the variance. Factors with the strongest independent positive association were ethnicity (African, American), less than a high school education, high medicare expenditures, and location in western or southern regions. Factors with the strongest independent negative associations were employment in agriculture and forestry, ethnicity (Hispanic), and per capita income. Wang *et al*. (2011) applied Poisson regression and linear regression to analyze the trend in the mortality rate for children under-five year of age and cause-specific mortality for children under-five years of age in China. The mortality rate for children under-five years of age dropped remarkably from 1996 to 2006. This reduction was mainly due to a significant decrease in deaths due to pneumonia and diarrhea.

1.6 Plan of thesis

This thesis contains five chapters. The introduction chapter discusses the background and rationale, objectives, expected advantages and literature reviews. Chapter 2 provides a description of the methodology and overviews the statistical methods for data analysis. Chapter 3 covers preliminary data analysis. Chapter 4 presents the statistical modeling, and confidence intervals. Chapter 5 presents the conclusions and discussion of the study.