# Geographical Variation of Mortality in Thailand

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***Objective:*** *To examine geographical variation of mortality in Thailand.*
***Material and Method:*** *Descriptive ecological study using the national vital registration data in 2000, age-specific mortality rate and cause-specific standardized mortality ratio (SMR) were presented at district geographic level.*
***Results:*** *Overall mortality was highly concentrated in the middle part of the upper north, as well as mortality of the working age. Clustering of cause-specific SMR in a single region was found for liver cancer (in the upper northeast region) and chronic obstructive pulmonary disease (in the upper north region). Clustering in multiple regions was found for renal failure (in the upper north and the upper northeast regions). Dispersed pattern of mortality with no regional clustering was found for leukemia. The geographical pattern of cause-specific mortality might be explained by distribution of incidence and related risk factors.*
***Conclusion:*** *Geographical variation of mortality exists and should be used as a target for reducing mortality gap across geographical areas.*

***Keywords:*** *Geographical variation, Mortality*

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Variation of mortality within countries has been a common measurement for assessing inequality of population health[1,2]. In developed countries, geographical inequalities in mortality have been routinely evaluated in terms of their magnitude and pattern for decades[3-5]. The existence of clustering of mortality was observed for some particular diseases such as cancer and cerebro-vascular disease[6-9]. In developing countries, the emphasis on measuring such health inequalities was to assess the situation and to plan for reduction[10]. However, lack of data at a small geographical area is a major limitation for developing countries to measure geographical inequality throughout the countries[11].

More literature has been found on spatial epidemiology[12] because of the influence of place of living (according to the concept of neighborhood) on individual health[13]. Measuring spatial distributions of diseases can help reflect the possible determinants of disease occurrence or outcome of health interventions, such as risk behaviors, socio-cultural factors, environmental factors, and availability of health care resources[13-15]. Spatial pattern of diseases has been currently explored for injuries and non-communicable diseases as these conditions are the results of interactions between behavior, life style, and environment related to residential area[6-9].

In order to measure the magnitude of geographical health inequality, small area data are recommended because of the lack of individual data to estimate individual health. The small area data can be used as a proxy of individual data under the assumption of homogeneity of personal characteristics among persons residing in the same small geographical area. The smaller the area, details of data variation can be better detected than the larger area data[11,16]. In Thailand, most of the studies have presented a rather

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large geographical variation of mortality and morbidity at the regional and provincial level. Geographical variation across smaller areas like district level was studied in a few specific health issues[17].

In the present study, the authors analyzed the variation of mortality in Thailand at a smaller area (district) level. Geographical variations of age-specific mortality and cause-specific mortality were assessed. The pattern of geographical variation in mortality can help target the priority for inequality reduction and set hypothesis for investigating possible determinants of disease and death.

## Material and Method

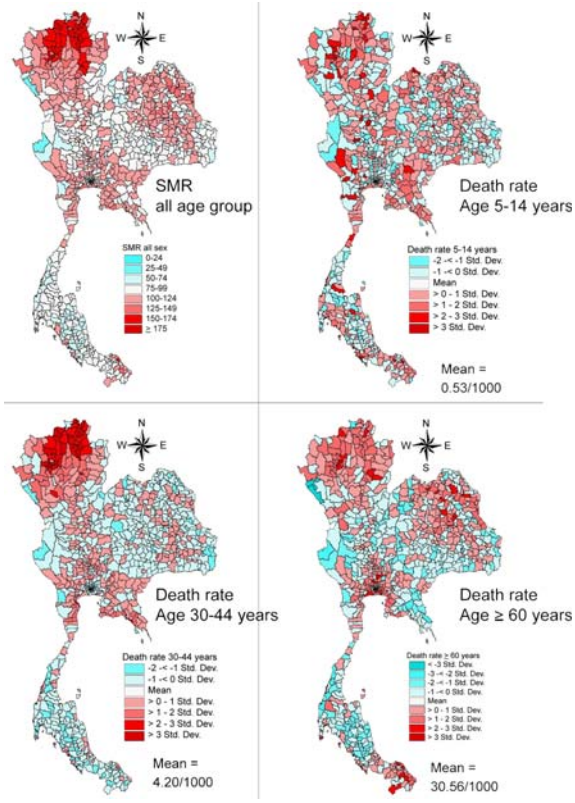
The present study used mortality data from death registration database in 2000 from the Ministry of Interior and coded the causes of death into the International Classification of Diseases version 10 (ICD-10) by the Bureau of Policy and Strategy, Ministry of Public Health. Population census database in 2000 from the National Statistical Office were used as the denominator for calculating mortality rate at district, provincial and regional levels. In 2000, there were 926 districts, 76 provinces and 10 regions (upper and lower north, upper and lower northeast, central, east, west, upper and lower south and Bangkok). Age-specific and cause-specific mortality rates were calculated. Thirteen causes of death used in the present study include tuberculosis, HIV/AIDS, liver cancer, lung cancer, leukemia, diabetes, ischemic heart disease, cerebrovascular disease (CVD), chronic obstructive pulmonary disease (COPD), renal failure, traffic accident, drowning, and suicide. Standardized Mortality Ratio (SMR) was calculated by dividing the observed number of deaths by the expected number of deaths for the overall mortality and cause-specific mortality at district level. Expected number of deaths for each area was calculated from national age-specific mortality rate and the age structure of population in that area. The present study used ArcGIS 9[18] to visualize the pattern of spatial distribution of mortality at the district level.

## Results

In 2000, the number of deaths was 365,741. Fig. 1 shows the patterns of geographical distributions of mortality between the overall mortality (SMR) and age-specific mortality rates for people aged 5-14, 30-44 years and 60 years and older.

The geographical distribution of the overall mortality (SMR) was concentrated in the middle part of the upper north followed by the other parts of the north, the upper northeast, and the east. For people aged 5-14 years, the distribution was dispersed with no localization at any specific region. At aged 30-44 years, the distribution was more localized in the middle part of the upper northern region. This pattern is similar to the pattern of the overall mortality. These districts' mortality rates were higher than twice of the standard deviation. For older people, the high mortality rates were diffused to the northeast and the central regions.

The geographical distributions of cause-specific mortality were assessed. People from the upper north faced higher deaths from HIV, COPD, renal failure and suicide. The ratio of SMR between the upper north and the regions with lowest SMR varied from 3.5 times for renal failure (compared with the upper south) to 6.3 times for HIV (compared with the lower south). People from the upper northeast faced higher deaths from liver cancer (17 times higher than people from the lower south). People from Bangkok




Source: Ministry of Interior and National Statistical Office

**Fig. 1** Geographical distributions of overall SMR and age-specific mortality rates (district) in 2000 (n = 365,741) number of death

faced higher deaths from lung cancer, heart disease, and diabetes while people from the east were more likely to die from traffic accidents (Table 1).

Visualization of geographical distribution can help reveal the regional clustering patterns. Liver cancer had a localized high mortality in the upper northeastern region. Almost all districts in this region had SMR higher than 175%. High SMRs of COPD were also localized in the upper northern region. For renal failure, high SMR districts seem to be localized in the upper north and the upper northeast. These three examples showed a regional clustering of mortality as a single region (such as liver cancer and COPD) and the multiple regions (such as renal failure). The third pattern was the dispersed geographical distribution observed in the case of leukemia (Fig. 2).

Another type of spatial distribution of mortality was observed in the case of HIV, diabetes, cerebro-vascular disease (CVD) and suicide. These causes of death had clusters of mortality in some parts of the regions. Clustering did not cover the entire region but scattered into multiple large and small clusters. In case of HIV, clusters of mortality were localized in the middle part of the upper north, the east coast of eastern regions and other small clusters. For diabetes, the upper northeast had a large cluster in addition to the lower part of the central region. For CVD, the clusters were formed in the lower north, the central, and the eastern regions. The clusters of suicide were formed largely in the upper north and scattered into multiple small clusters in the lower north and the east regions (Fig. 3).

**Discussion**

Results from the present study demonstrate that the geographical pattern of cause-specific mortality was localized in some specific regions for particular ages and causes of death. A clustering pattern of mortality in a single region (almost entire region) was found in liver cancer (the upper northeast) and chronic obstructive pulmonary disease (the upper north). Clustering of mortality in multiple regions was found in renal failure (the upper north and the upper northeast) for instance. Dispersed pattern with no clustering in any specific region was found in leukemia. Clustering in some specific areas but not for the entire region with possible small clusters diffused in multiple regions was found in the working age group, HIV, diabetes, cerebro-vascular disease, and suicide.

A more prominent geographical variation of mortality in the working age group (25-44 years old) was found in other studies[19]. Geographical variation was also high in the middle age group (45-59 years). Both mortality at the working age and the middle age groups were defined as the premature mortality as they were preventable causes of death[20]. For the elderly, geographical variation declines according to the similar high probability of mortality in all areas.

These patterns of geographical distribution of age-specific mortality revealed that the mortality of the working age group was mostly influenced by the distribution of the overall mortality. Reduction in mortality in this age group especially in the high mortality area would eventually reduce the average and the variations of mortality among populations across

**Table 1.** Regions with highest and lowest SMR for 13 causes of mortality in 2000

| Causes of death | Region with highest and lowest SMR | | Highest:Lowest mortality ratio |
|---|---|---|---|
| | Highest | Lowest | |
| Liver cancer | Upper north-east | Lower south | 16.9 |
| HIV/AIDS | Upper north | Lower south | 6.3 |
| Suicide | Upper north | Bangkok | 5.6 |
| Traffic accident | East | Bangkok | 4.2 |
| Lung cancer | Bangkok | Lower south | 4.0 |
| COPD | Upper north | Upper north-east | 4.0 |
| Renal failure | Upper north | Upper south | 3.5 |
| Cerebro-vascular disease | Bangkok | Upper north-east | 3.1 |
| Ischemic heart disease | Bangkok | Upper north-east | 2.8 |
| Drowning | East | Lower south | 2.5 |
| Diabetes | Bangkok | Upper south | 2.4 |
| Leukemia | Upper north-east | Lower south | 2.0 |
| Tuberculosis | West | Lower north | 2.0 |

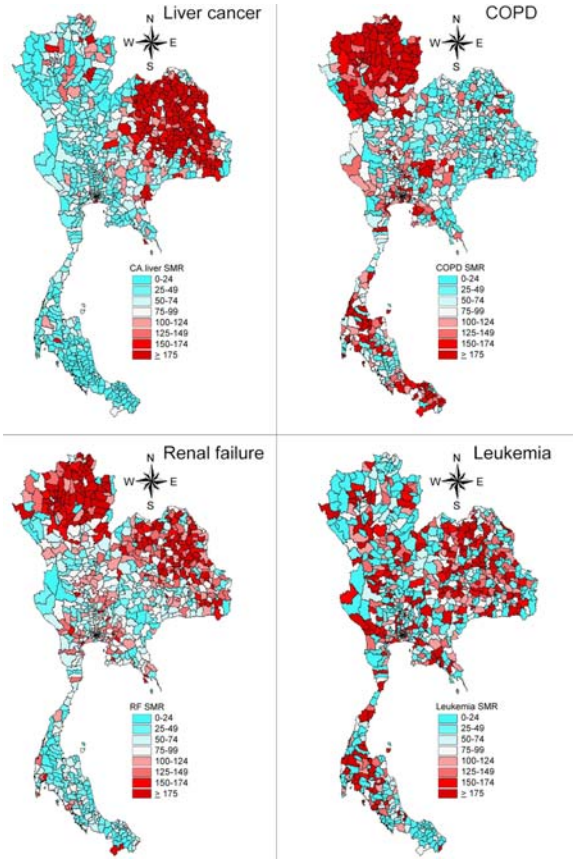



**Fig. 2** Geographical distributions of district SMR for liver cancer, COPD, renal failure and leukemia in 2000

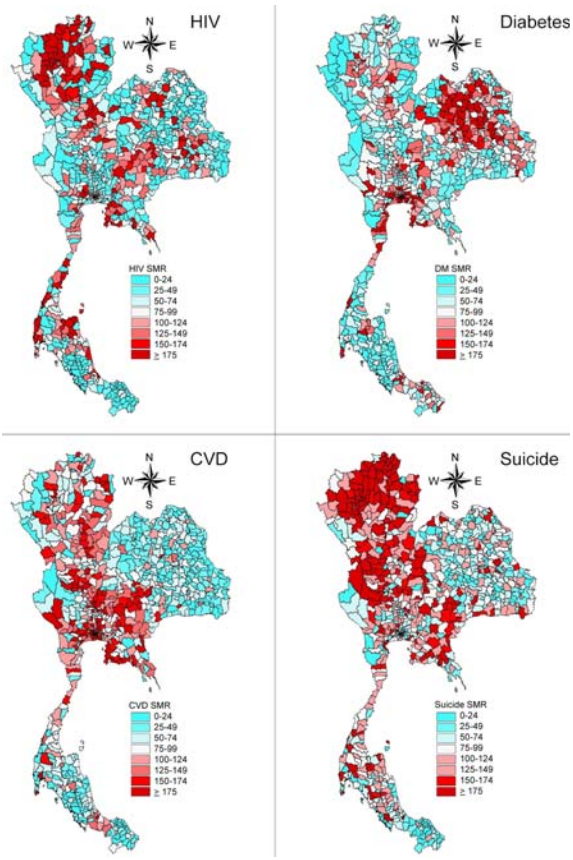



**Fig. 3** Geographical distributions of district SMR for HIV, diabetes, CVD and suicide in 2000

geographical areas. According to the study in 1999, deaths from HIV occupied the topmost cause of death in the working age followed by traffic accidents and suicide respectively[21]. This evidence confirms the similar pattern of geographical distribution between HIV mortality and mortality at aged 30-44 years and the overall mortality (Fig. 1, 3).

The explanation of geographical clustering of cause-specific mortality is mainly related to the clustering of disease-specific incidence or risk factors assuming that the case-fatality rate across areas is constant. For HIV, the middle part of the upper north had the highest mortality as well as highest prevalence of HIV infection as monitored by the sero-prevalence sentinel surveillance system[17]. According to the lag time between contracting infection and mortality, geographical distribution of HIV mortality in 2000 shown in the present study is closer to the geographical distribution of HIV infection in 1993 than in 2000[17].

Clustering of high mortality from liver cancer in the upper northeast can be explained mainly by the high prevalence of liver fluke and subsequently the high incidence of cholangiocarcinoma[22]. Food habit of eating raw fish and the existence of reservoirs for liver fluke in the river are the main factors of high incidence and mortality from liver cancer in this region. The two most common types of liver cancer in Thailand are cholangiocarcinoma and hepatocellular carcinoma most common; liver cancer in this region was cholangiocarcinoma not heptocellular carcinoma.

Clustering of COPD mortality in the north can be explained by the high smoking rate in this area[23]. According to the lag time between smoking and mortality from COPD, geographical distribution of COPD mortality in this year would resemble the smoking pattern decades ago. Recent decline of smoking habit in the north[23] would influence a declining trend of COPD mortality in the region and the distribution

pattern of COPD mortality in the future would eventually change.

Clustering of mortality from diabetes in the northeast might be explained by the recent finding on the relationship between low birth weight and risk of type 2 diabetes in the later life[24]. People in the northeast are the poorest compared to people in other regions. As a result, malnourishment and high proportion of low birth weight babies would be expected and subsequently type 2 diabetes in the later life. The mechanism of low birth weight influencing type 2 diabetes is explained elsewhere[25]. For the central region, a high proportion of obesity and hypertension would be the major risk factors[26].

Clustering of mortality from other causes of death might be related to biological and behavioral risk factors, underlying socio-economic condition, socio-cultural context, and environment. Suicide is a good example for the influence of socio-cultural context that might affect coping behaviors of the people. Recently, maladaptive lifestyle is concerned as one of the precipitating factors for a high suicidal rate in the north[27].

The results of the present study can be used for formulating health policy at the national and local levels. Prioritization and resources allocation processes should concern with information on geographical variations of major health problems in order to ensure allocative efficiency and equity of health system. The area with higher magnitude of particular health problems should receive higher attentions in terms of efforts and resources.

Moreover, the patterns of geographic distributions of cause-specific mortality can help generate hypotheses for further in-depth studies in order to investigate the probable causes that determine geographical variation of occurrence of diseases and mortality especially in the regions with high mortality risk. More advanced statistical and spatial analyses should be performed to prove such relationships.

In conclusion, geographical variations of mortality exist in Thailand, especially mortality of the working age group and cause-specific mortality. There were regional variations in many preventable diseases that should be used as the target for reducing the variations by undertaking effective health care interventions.

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## *การกระจายของการตายตามพื้นที่ภูมิศาสตร์ในประเทศไทย*

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***วัตถุประสงค์****: เพื่อศึกษาการกระจายของการตายตามพื้นที่ภูมิศาสตร์ในประเทศไทย*
***วิธีการศึกษา****: เป็นการศึกษาเชิงพรรณนา โดยใช้ข้อมูลการตายทั่วประเทศปี พ.ศ. 2543 นำเสนออัตราตายรายอายุ และอัตราส่วนการตายมาตรฐานรายสาเหตุ ตามแผนที่ภูมิศาสตร์ระดับอำเภอ*
***ผลการศึกษา****: การตายรวมทุกสาเหตุ มีการกระจุกตัวอยู่ที่บริเวณตอนกลางของภาคเหนือตอนบน เช่นเดียวกับการตายของกลุ่มวัยทำงาน ลักษณะการตายที่กระจุกเฉพาะภาคเดียว พบในการตายด้วยโรคมะเร็งตับ (เฉพาะภาคตะวันออกเฉียงเหนือตอนบน) และโรคปอดอุดกั้นเรื้อรัง (เฉพาะภาคเหนือตอนบน) ลักษณะการตายที่กระจุกมากกว่าหนึ่งภาคพบในการตายด้วยไตวาย (ภาคเหนือตอนบน และภาคตะวันออกเฉียงเหนือตอนบน) ลักษณะการตายที่กระจายทั่วไปไม่เกาะกลุ่ม พบในโรคมะเร็งเม็ดเลือดขาว โดยลักษณะการกระจายทางภูมิศาสตร์ของการตายรายสาเหตุส่วนหนึ่งอธิบายได้จากอุบัติการณ์ของโรคที่แตกต่างกัน และปัจจัยเสี่ยงที่เกี่ยวข้อง*
***สรุป****: มีความแตกต่างของการตายตามภูมิศาสตร์ในประเทศไทย ซึ่งควรนำมาใช้กำหนดเป้าหมายลดช่องว่างของการตายระหว่างพื้นที่ของประเทศไทย*