การตายของเด็กอายุต่ำกว่า 5 ปี ในประเทศไทย โดยใช้ช่วงความเชื่อมั่นจากตัวแบบล็อกเชิงเส้น

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บทคัดย่อ

อัตราการตายของเด็กอายุต่ำกว่า 5 ปี เป็นหนึ่งในตัวชี้วัดทางด้านสุขภาพที่ใช้ในการเปรียบเทียบกันระหว่างประเทศ อัตราการตายของเด็กอายุต่ำกว่า 5 ปี ในประเทศไทยยังคงสูง การศึกษานี้มีวัตถุประสงค์เพื่อศึกษาแนวโน้มและความแตกต่างระหว่างพื้นที่ของการตายของเด็กอายุต่ำกว่า 5 ปี ในประเทศไทยตั้งแต่ปี ค.ศ. 2000 ถึง 2009 ข้อมูลที่ใช้ในการศึกษาประกอบด้วยจำนวนการตายของเด็กอายุต่ำกว่า 5 ปี ทั้งหมดที่รายงานของประเทศไทยตั้งแต่ปี ค.ศ. 2000 ถึง 2009 โดยได้รับมาจากกระทรวงสาธารณสุข สร้างตัวแบบล็อกเชิงเส้นที่มีตัวแปรเพศ เขตสุขภาพ และ ปี เป็นตัวแปรทำนาย และสร้างช่วงความเชื่อมั่นแบบเปรียบเทียบกับค่าเฉลี่ยรวมของอัตราการตายของแต่ละกลุ่มที่ปรับอิทธิพลของตัวแปรอื่นในตัวแบบ ผลการศึกษาพบว่าในช่วงปี ค.ศ. 2000 ถึง 2009 จำนวนการตายของเด็กอายุต่ำกว่า 5 ปี ที่รายงานมีทั้งหมด 84,227 ราย ตัวแบบล็อกเชิงเส้นมีความเหมาะสมกับข้อมูล โดยพิจารณาจากกราฟของเศษเหลือ อัตราการตายเฉลี่ยคิดเป็น 177.9 คน ต่อประชากร 100,000 คน อัตราการตายมีแนวโน้มลดลงยกเว้น ปี ค.ศ. 2001 พื้นที่ที่มีอัตราการตายสูงของประเทศไทย คือ ภาคกลาง (เขตสุขภาพที่ 2 เขตสุขภาพที่ 3 และเขตสุขภาพที่ 4) และ ภาคใต้ตอนล่าง (เขตสุขภาพที่ 12) การศึกษาครั้งนี้ได้สารสนเทศเชิงพื้นที่ที่เป็นประโยชน์กับหน่วยงานด้านสาธารณสุขและผู้เกี่ยวข้องในการกำหนดนโยบายวางแผนสุขภาพเชิงพื้นที่ต่อไป

คำสำคัญ: ตัวแบบล็อกเชิงเส้น ช่วงความเชื่อมั่น การตายของเด็กต่ำกว่า 5 ปี

Under-five Mortality in Thailand based on Confidence Intervals from a Log-linear Model

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Abstract

The under-five mortality rate is one of the indicators to understand a country's public health position in relation to other countries. Since the under-five mortality of Thailand remained high, this study investigated trends and geographical variations of under-five mortality in Thailand from 2000 to 2009. Data included all reported Thai under-five deaths from the decade (2000-2009) obtained from the Thai Ministry of Public Health. A log-linear model based on sum contrasts was fitted to under-five mortality rates as an additive linear function of sexes, public health areas (PHA), and years. The model gave adjusted confidence intervals for mortality rates for levels of each determinant adjusted for other factors. Results revealed that there were 84,227 records of under-five deaths within the decade. The log-linear model provided a good fit, as indicated by the residual plot. On average, the decade death rate was 177.9 per 100,000 population, while mortality trends tended to decrease except for 2001. High rates occurred in Central (PHA2, PHA3, and PHA4) and Lower Southern (PHA12) Thailand. This study highlighted the locations to which public health authorities should direct their intervention plans.

Keywords: log-linear model, democratic confidence intervals, under-five mortality

Introduction

The under-five mortality rate of Thailand in 2010 was 9.8 per 1,000 live births (decreased from 12.8 in 1990) (Ministry of Public Health of Thailand, 2010; Hill et al., 2007). Although the UN Millennium Development Goals report in 2010 published an aim to reduce the mortality of children younger than five years by two-thirds between 1990 and 2015, several countries had not been on track to meet this target (Liu et al., 2012; Block et al., 2008). Therefore, to discover if this goal could be met, there is an increased demand for the analysis of national mortality data.

The average child mortality rates were 6 per 1,000 live births in industrialized countries (decreased from 10 per 1,000 live births in 1990) and 63 per 1,000 live births in developing countries (decreased from 97 in 1990) (UNICEF, 2012). According to under-five mortality rates, gross national income per capita, and life expectancy at birth, Thailand's status was reportedly ahead of UNICEF's developing countries but substantially behind "industrialized countries."

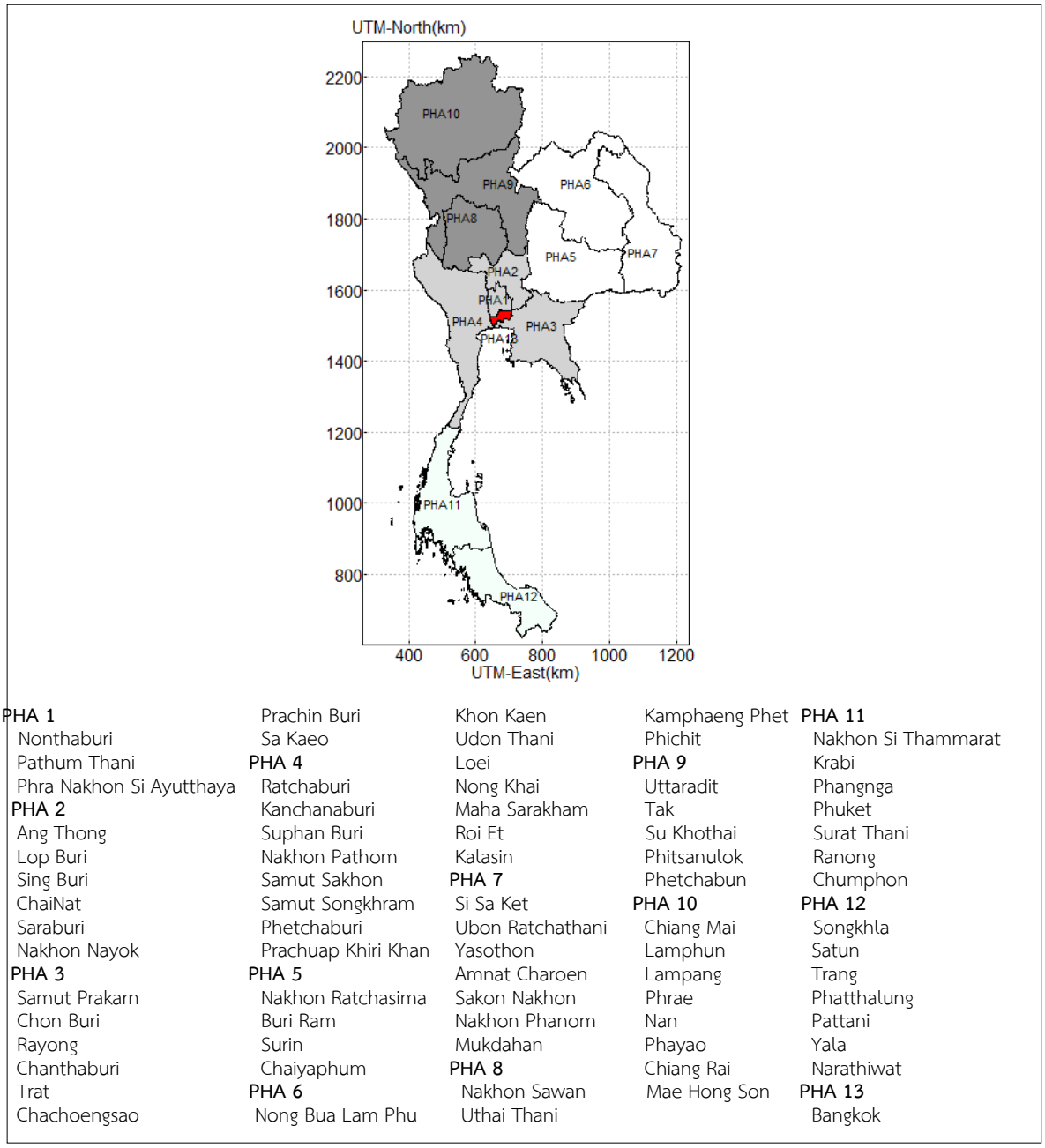
To learn from success and identify rooms for improvement to accelerate the declination of under-five mortality, comprehensive measurements are needed at national and micro levels. Hence, this study aimed to investigate geographical patterns and trends of under-five mortality in Thailand from 2000 to 2009.

Materials and Methods

Data sources

All reported deaths of under-five years from 2000 to 2009 were obtained from the Bureau of Health Policy and Strategy, Ministry of Public Health of Thailand. The data were ages, sexes, provinces, and causes of death of the deceased individuals extracted from death certificates using the Tenth Revision of the International Classification of Diseases (ICD-10).

Provinces were grouped into 13 public health areas (PHA) for statistical accuracy, as elaborated in Figure 1.



PHA 1	Prachin Buri	Khon Kaen	Kamphaeng Phet	**PHA 11**
Nonthaburi	Sa Kaeo	Udon Thani	Phichit	Nakhon Si Thammarat
Pathum Thani	**PHA 4**	Loei	**PHA 9**	Krabi
Phra Nakhon Si Ayutthaya	Ratchaburi	Nong Khai	Uttaradit	Phangnga
PHA 2	Kanchanaburi	Maha Sarakham	Tak	Phuket
Ang Thong	Suphan Buri	Roi Et	Su Khothai	Surat Thani
Lop Buri	Nakhon Pathom	Kalasin	Phitsanulok	Ranong
Sing Buri	Samut Sakhon	**PHA 7**	Phetchabun	Chumphon
ChaiNat	Samut Songkhram	Si Sa Ket	**PHA 10**	**PHA 12**
Saraburi	Phetchaburi	Ubon Ratchathani	Chiang Mai	Songkhla
Nakhon Nayok	Prachuap Khiri Khan	Yasothon	Lamphun	Satun
PHA 3	**PHA 5**	Amnat Charoen	Lampang	Trang
Samut Prakarn	Nakhon Ratchasima	Sakon Nakhon	Phrae	Phatthalung
Chon Buri	Buri Ram	Nakhon Phanom	Nan	Pattani
Rayong	Surin	Mukdahan	Phayao	Yala
Chanthaburi	Chaiyaphum	**PHA 8**	Chiang Rai	Narathiwat
Trat	**PHA 6**	Nakhon Sawan	Mae Hong Son	**PHA 13**
Chachoengsao	Nong Bua Lam Phu	Uthai Thani		Bangkok

Figure 1: The Public Health Area (PHA) map of Thailand

The corresponding populations at risk were obtained from the Institute for Population and Social Research, Mahidol University.

Statistical methods

As illustrated below, death rates (y_{ijt}) were computed using children deaths under five years divided by mid-year population and multiplied by 100,000 population.

$$y_{ijt} = \frac{D_{ijt}}{P_{ijt}} \times K \qquad (1)$$

From the formula, D_{ijt} refers to the number of deaths by sex i (i = 1, 2), PHA j (j = 1, 2, 3, ...,13), and year t (t = 2000, 2001, 2002, ..., 2009), whereas P_{ijt} represents the corresponding population at risk and K is the constant of 100,000 in this case.

The death rate is a continuous outcome and generally has positively skewed distributions. Hence, it is conventional to transform them by taking logarithms. The model for death rates takes the form:

$$ln(y_{ijt}) = \mu + \alpha_i + \beta_j + \gamma_t \quad (2)$$

Moreover, y_{ijt} refers to the death rate in the i, j, and t groups of determinant factors. μ refers to a constant. α_i, β_j and γ_t refer to a sex, a PHA, and a year, respectively.

Confidence intervals

Sum contrasts (Venables & Ripley, 2002; Tongkumchum & McNeil, 2009) were used when fitting the model to obtain confidence intervals, which were further employed in the comparisons between means and the overall mean. One advantage of confidence intervals is that they provide a simple criterion for classifying levels of the factor into three groups according to whether each corresponding confidence interval exceeds, crosses, or is below the overall mean. The confidence intervals based on sum contrasts were utilized due to suitability compared to treatment contrasts. They applied equitably to each factor level, whereas the commonly used confidence intervals based on treatment contrasts measured the difference from a reference group taken to be fixed and thus not having a confidence interval.

All statistical modeling and graphical displays were performed using R statistical software (R Development Core Team, 2017).

Results

Preliminary results

Over the decade of 2000-2009, there were 84,227 under-five deaths, constituting 0.2% of all deaths. Moreover, the decade-average mortality was 177.9 per 100,000 population. By region, the rates ranged from 152.9 in the Northeast to 204.1 in the South. By PHA, the rates ranged from 141.0 in PHA5 (Northeast) to 236.4 in PHA12 (Lower South). Furthermore, the rates slightly varied by year, ranging from 169.3 in 2009 to 199.8 in 2001.

Figure 2 shows mortality trends by sex and PHA. Trends of both sexes tended to decline in most PHAs, except for PHA2 and PHA4 (Central) and PHA12 (Lower South). The trend of PHA13 (Bangkok) has been dramatically decreasing.

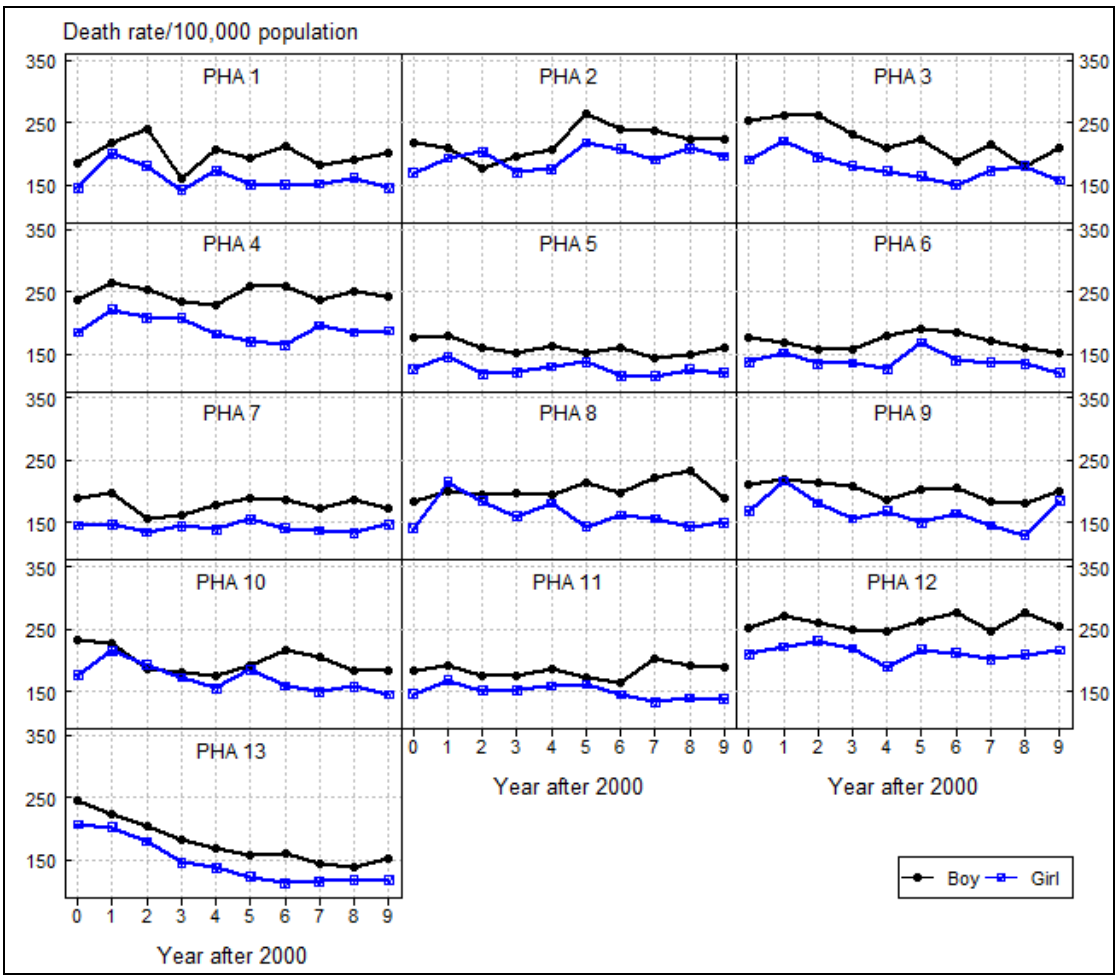


Figure 2: The rates of under-five mortality per 100,000 population

Log-linear model results

As illustrated in Figure 3, the standardized residual plot was obtained from fitting the log-linear model of Equation 2 to the natural logarithm of under-five mortality rates, and evidently, it indicated that the model fitted well with the data with an r-squared of 78.8%.

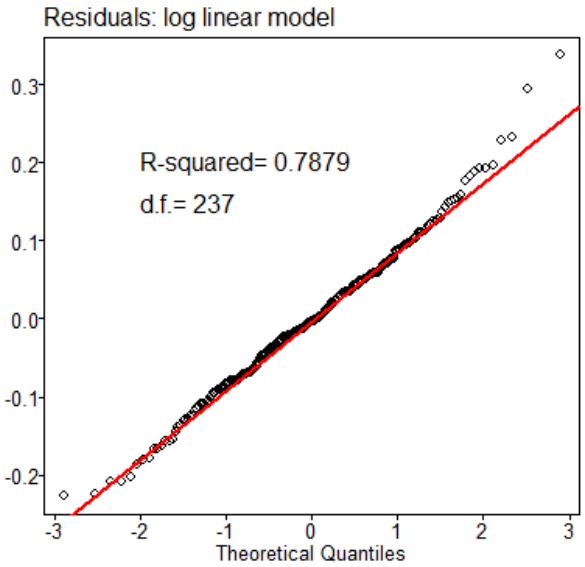


Figure 3: The residual plot of the log-linear model

The confidence intervals of the adjusted under-five mortality rates from the log-linear model are as displayed in Figure 4. The horizontal blue line signifies the decade death rate of 177.9 per 100,000. A decreasing trend was identified based on the adjusted under-five mortality rates from 2000 to 2009, except for 2001.

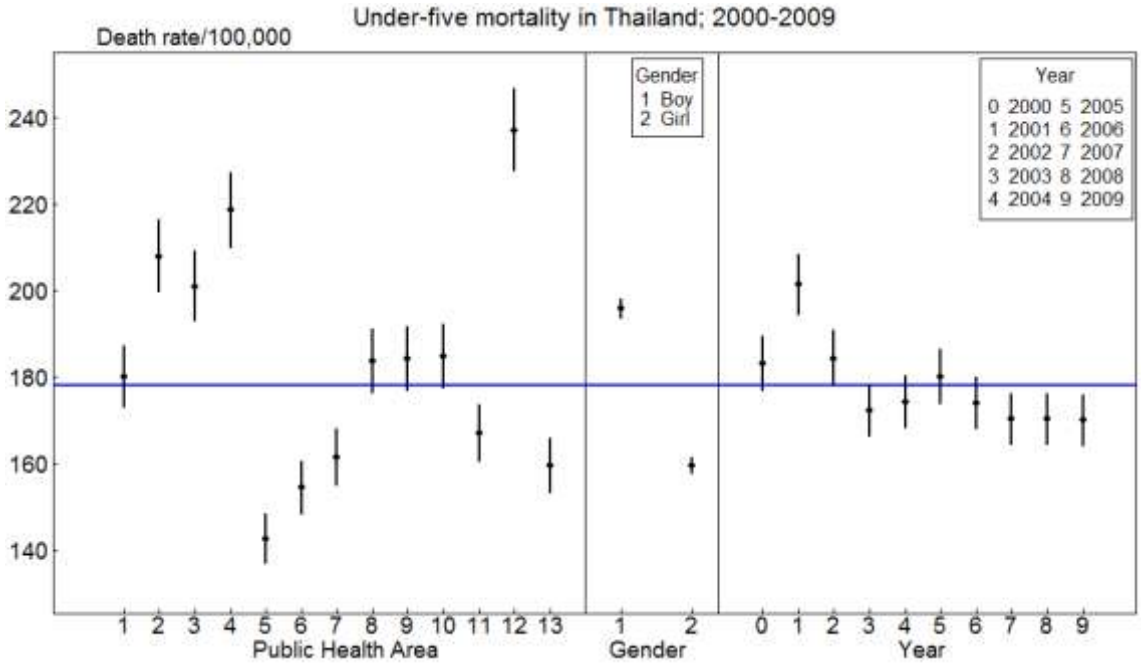


Figure 4: The 95% confidence interval plot of under-five mortality rates per 100,000 population

The stacked bar chart of the confidence intervals in Figure 5 demonstrated that differences in under-five mortality among PHAs were significant. Furthermore, the highest of under-five deaths occurred in Southern (PHA12) and Central (PHA2, PHA3, and PHA4) Thailand.

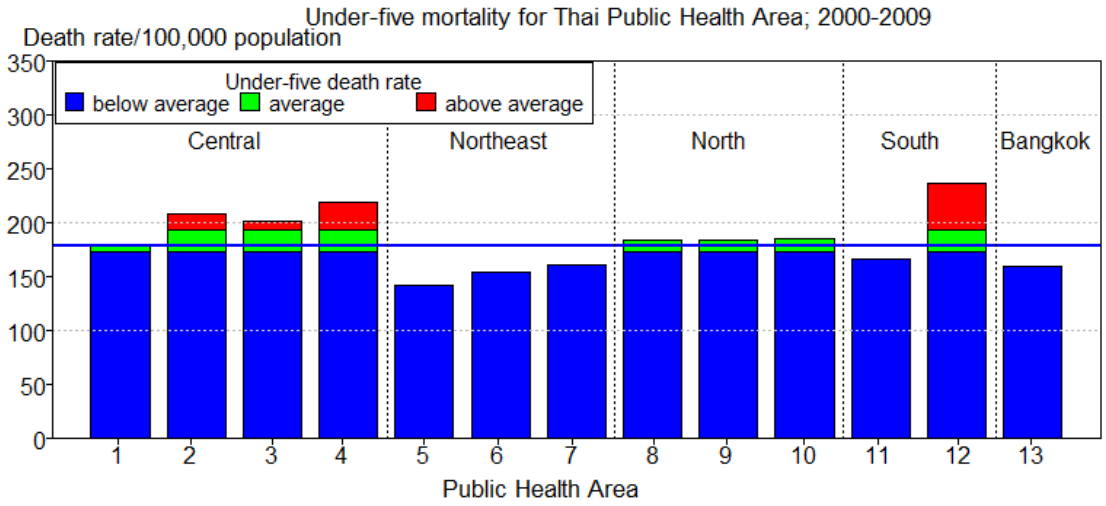


Figure 5: The stacked bar chart of the confidence intervals in under-five mortality

Discussion

Based on the death certificates, the under-five deaths of children accounted for 0.2% of all the deaths recorded from 2000 to 2009, with a decade average of 177.9 per 100,000 population.

The trends declined consistently with a previous study (Tangcharoensathien, 2006), suggesting that Thailand might be on track to achieve the fourth Millennium Development Goal (MDG4), which is to lower under-five mortality by two-thirds from 1990 through 2015. Unfortunately, many countries could not maintain the pace and were reportedly unlikely to meet the goal (Black et al., 2010, Liu et al., 2012) even though 70% of the global causes of under-five fatalities are preventable (WHO, 2012; Liu et al., 2012). Nevertheless, Thailand had been relatively constant at maintaining substantial reductions in under-five mortality rates over the past decade, although such reductions across the country varied significantly by economic conditions (Vapattanawong et al., 2007). Therefore, further research is suggested to focus on this domestic variation together with the causes of fatalities.

Mortality rates for children under five were high in Central (PHA2, PHA3, and PHA4) and Southern (PHA12) Thailand. Our findings were congruent with Vapattanawong (2009) and Vapattanawong et al. (2007), which reported a provincial variation in Thailand's under-five mortality. Consequently, prevention policies should be formulated by targeting these areas.

Since this study employed the national vital registration database, the obtained data might involve underestimated under-five mortality rates (Hill et al., 2012), meaning that the actual rates could be higher than what this study had published. Therefore, data sources with more accurate national

mortality estimates are needed to acquire absolute values based on this notion. In addition, adjustment factors and alternative sources, such as verbal autopsy studies, are also essential.

Although the absolute values of death rates were less reliable due to under-reporting (Pattaraarchachai et al., 2010; Polprasert et al., 2010; Rao et al., 2010; Porapakkham et al., 2010; Tangcharoensathien et al., 2006), relative figures remained useful since they could be utilized to identify locations where public health authorities should target the prevention of under-five mortality. Furthermore, statistical methods used in this study could be applied to mortality data from other causes. Graphs of the confidence intervals and the stacked bar chart provided quick visualization of the results from the log-linear model, while the confidence intervals provided inferential information and guided the drawing of conclusions from the data.

Conclusion

This study investigated the pattern and trends of under-five mortality rates in various provinces of Thailand. The results from model fitting were illustrated using confidence intervals, a bar chart, and a thematic map showing provinces with high and low under-five mortality rates. Using a thematic map to display the levels of under-five mortality by public health areas and provinces could provide beneficial insights for public health authorities to prioritize their intervention plans more effectively.

Acknowledgment

This work was supported by a grant from the Graduate School and Faculty of Science and Technology, Prince of Songkla University. We are grateful for the contribution of the Bureau of Health Policy and Strategy, Ministry of Public Health of Thailand, who provided the data. Professor Don McNeil is acknowledged for his valuable guidance and suggestion.

Conflict of Interest

The authors have no conflict of interests to declare.

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