



Original Article

Pregnancy-associated mortality in Taiwan, 2004–2011



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ABSTRACT

Objective: Pregnancy-associated death is defined by the American College of Obstetricians and Gynecologists as “a death of a woman while pregnant or within 1 year of termination of pregnancy, irrespective of the cause of death.” We sought to determine pregnancy-associated mortality ratio (PAMR) in Taiwan and to compare the cause of death pattern with other countries to assess the national health status of Taiwanese women.

Materials and methods: We linked four nationwide population-based data sets (birth registration, birth notification, National Health Insurance claims, and cause of death mortality) from 2004 to 2011 to identify women aged 15–49 years that died from pregnancy-associated deaths. We then calculated the PAMR and cause of death distribution by maternal age.

Results: A total of 559 pregnancy-associated deaths were identified with an overall PAMR of 36 (deaths per 100,000 live births). The J-shaped age-specific PAMR mortality pattern was noted, in which the PAMR was 32, 25, 24, 36, 71, 143, and 369 for women aged 15–19 years, 20–24 years, 25–29 years, 30–34 years, 35–39 years, 40–44 years, and 45–49 years, respectively. The age-standardized PAMR decreased drastically from 45 in 2004–2005 to 36 in 2006–2007 and 30 in 2008–2009, but leveled off to 33 in 2010–2011. The proportion of indirect causes increased from 2004–2007 to 2008–2011 among women aged 15–29 years and 35–49 years.

Conclusion: Compared with previous studies, the PAMR of Taiwan is moderate. However, the proportion of external causes of pregnancy-associated deaths in Taiwan is the lowest compared with other regions. Further studies (such as death review) are needed to explore possible preventable factors.

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Introduction

Maternal mortality is a commonly used national indicator of health status of women [1]. Maternal death is defined by the World Health Organization as “the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes” [2]. One of the limitations of this

definition is that many deaths from direct causes (such as amniotic fluid embolism, postpartum hemorrhage, or eclampsia) or indirect causes (such as cardiovascular diseases or infectious diseases) might occur more than 42 days after termination of pregnancy with the help of advanced medical technology [3]. Another limitation is that this definition restricts to only biologically related causes of death. However, as indicated by Frye [4], some deaths are socially related to the pregnancy and may not have occurred without pregnancy, such as suicide due to postpartum depression, homicide due to intimate partner violence on pregnant or postpartum women, or motor vehicle crashes due to eclampsia.

To address these limitations, a new term “pregnancy-associated death” was proposed by the Centers for Disease Control and Prevention, in collaboration with the Maternal Mortality Special Interest Group of the American College of Obstetricians and

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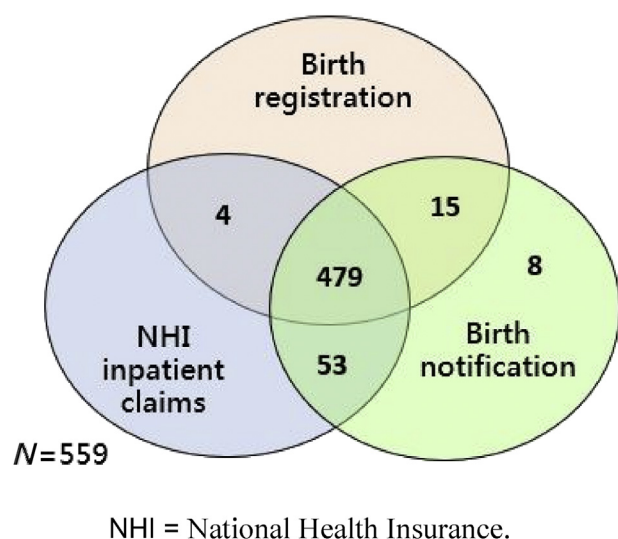


Figure 1. The number of pregnancy-associated deaths identified from different data sources according to linked data in Taiwan, 2004–2011.

Gynecologists to define it as “death of a woman while pregnant or within 1 year of termination of pregnancy, of the cause of death” [5,6]. Although the concept of “pregnancy-associated death” was proposed in 1986, few studies have examined the pregnancy-associated mortality ratio (PAMR) and most have been confined to one state in the United States and examined only a small number of cases [7–10]. One of the reasons why there were few studies on this topic is that official published mortality data used the traditional definition (i.e., maternal death) set by the World Health Organization, it is therefore difficult to identify the pregnancy-associated deaths. Only through the enhanced surveillance of different sources (such as birth certificate, fetal certificate, hospital medical records, or autopsy reports) we could identify the pregnancy-associated deaths. Furthermore, no study has been performed on this issue in Asian countries. We thus undertook this study to determine PAMR in Taiwan and to compare the cause of death pattern with other countries to assess the health status of Taiwanese women.

Materials and methods

Data sources

We linked four nationwide population-based data sets [i.e., birth registration, birth notification, National Health Insurance (NHI) inpatient claims, and cause of death mortality data] to identify pregnancy-associated deaths for years 2004–2011. As the four data sets were maintained by different government sectors, we could link these data only through the Collaboration Center of Health Information Application, which was established by the Department

of Statistics, Ministry of Health and Welfare [11]. To avoid the release of personal information recorded in the data sets, the linkage analyses were conducted in an isolated, restricted-access room. Only aggregated statistical tables without a single cell with a number of counts below three were released to the investigators.

Measures

To identify pregnancy-associated deaths, we used identification information to link the data of women aged 15–49 years from 2004 to 2011. Because the number of cases linked between the NHI claims data and the cause of death mortality data was excessive, we included only NHI inpatient claims data with pregnancy-related diagnoses (ICD-9-CM codes 630–676 or V27) recorded in one of five discharge diagnoses. Subsequently, we confined the study to deaths in which the birth and death dates were within 365 days, in accordance with the Centers for Disease Control and Prevention in collaboration with the Maternal Mortality Special Interest Group of the American College of Obstetricians and Gynecologists definition of pregnancy-associated death.

We further classified the causes of pregnancy-associated deaths as “direct,” “indirect,” or “external” according to two information sources: one from diagnoses recorded in the NHI inpatient claims data and the other from the causes of death diagnosis reported on the death certificate. “Direct” causes of death are those resulting from obstetric complications (e.g., amniotic fluid embolism, postpartum hemorrhage, and preeclampsia/eclampsia), interventions, omissions, incorrect treatment, or a chain of events resulting from any of these (ICD-9-CM codes 630–676). “Indirect” causes of death are those resulting from an existing disease or a disease that developed during pregnancy and was not due to any of the direct obstetric causes but was aggravated by the physiological effects of pregnancy, such as cerebrovascular and cardiac diseases (ICD-9-CM codes 001–629, 680–759, or 780–789). “External” causes are unintentional injury (e.g., motor vehicle traffic crashes, falls, unintentional poisoning or complications of medical or surgical procedures), suicide, or homicide (ICD-9-CM codes E800–E999).

Statistical analysis

We first calculated overall and maternal age-specific PAMR (deaths per 100,000 live births) using data from 2004–2011 combined. We then computed age-standardized PAMR for years 2004–2005, 2006–2007, 2008–2009, and 2010–2011. Next, we compared the distribution of causes of pregnancy-associated deaths across years. Finally, we compared the pattern of mortality of Taiwan estimated in this study with those in previous studies.

Results

We initially extracted 644 potential pregnancy-associated deaths from the four linked data sets. We identified seven deaths

Table 1
Number and mortality ratio (deaths per 100,000 live births) of pregnancy-associated deaths by maternal age according to linked data in Taiwan, 2004–2011.^a

Maternal age (y)	No. of deaths	%	No. of live births	%	Mortality ratio
15–19	11	2.0	34,159	2.2	32.2
20–24	57	10.2	230,261	14.8	24.8
25–29	133	23.8	550,437	35.4	24.2
30–34	190	34.0	532,424	34.2	35.7
35–39	129	23.1	182,666	11.7	70.6
40–44	36	6.4	25,131	1.6	143.2
45–49	3	0.5	814	0.1	368.6
Total	559	100.0	1,555,892	100.0	35.9

^a Numerator of mortality ratio is the number of pregnancy-associated deaths and the denominator of mortality ratio is the number of live births.

Table 2

Number and mortality ratio (deaths per 100,000 live births) of pregnancy-associated deaths by maternal age and year according to linked data in Taiwan, 2004–2011.^a

	15–29 y		30–34 y		35–49 y		All ages	
	No.	Ratio	No.	Ratio	No.	Ratio	No.	Ratio
2004–2005	73	28.4	55	45.4	50	111.9	178	45.4
2006–2007	55	24.4	47	35.7	39	79.0	141	35.6
2008–2009	43	22.6	41	28.9	35	64.1	119	30.3
2010–2011	30	21.2	47	34.1	44	73.4	121	32.6

^a Numerator of mortality ratio is the number of pregnancy-associated deaths and the denominator of mortality ratio is the number of live births.

in which the birth date was incorrectly recorded earlier than the death date and 78 deaths not recorded in the birth certificate registration or birth report data sets. After excluding these cases, we identified 559 pregnancy-associated deaths. Figure 1 illustrates data sources for the identified cases.

The overall PAMR was 36 (deaths per 100,000 live births) during the study period. The J-shaped age-specific PAMR mortality pattern was noted, in which the PAMR was 32, 25, 24, 36, 71, 143, and 369 for women aged 15–19 years, 20–24 years, 25–29 years, 30–34 years, 35–39 years, 40–44 years, and 45–49 years, respectively (Table 1). The age-standardized PAMR decreased drastically from 45 in 2004–2005 to 36 in 2006–2007 and 30 in 2008–2009, but leveled off to 33 in 2010–2011 (Table 2).

With regard to the causes of pregnancy-associated deaths, the proportion of indirect causes increased from 2004–2007 to 2008–2011 among women aged 15–29 years and 35–49 years, but decreased among women aged 30–34 years (Figure 2). For women aged 30–34 years, the percentage of external causes increased substantially from 23% in 2004–2007 to 35% in 2008–2011.

Table 3 illustrates the findings of this study compared with previous studies. The estimated PAMR of Taiwan was 36, which is moderate compared with previous studies (27–89) [7–10]. The

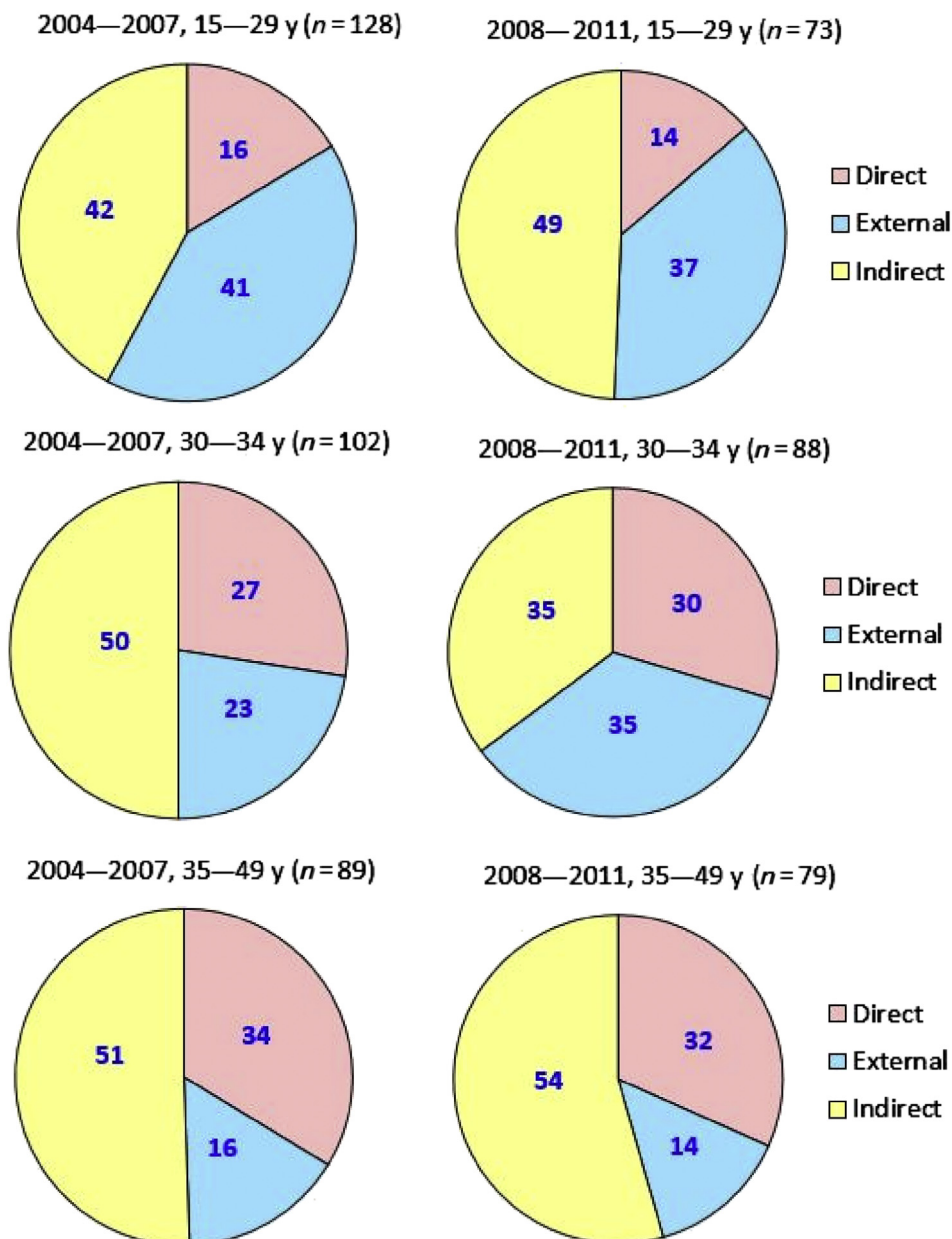


Figure 2. Distribution of causes of pregnancy-associated deaths by maternal age and year according to linked data in Taiwan, 2004–2011.

Table 3
Summary of findings of pregnancy-associated deaths studies.

	Finland [7]	Maryland [8]	Massachusetts [9]	Louisiana [10]	This study
Data (y)	1987–1994	1993–1998	1990–1999	2000–2005	2004–2011
No. of deaths	281	247	232	345	559
Mortality ratio	41.4		27.2	88.9	35.9
Cause of death					
Direct	26 (9.3)			52 (15.1)	140 (25.0)
Hypertension-related		16 (6.5)		11 (3.2)	
Obstetric embolism		21 (8.5)		9 (2.6)	
Postpartum hemorrhage		17 (6.9)			
Others				32 (9.3)	
Indirect	101 (35.9)			138 (27.1)	260 (46.5)
Circulatory disease		48 (19.4)		42 (12.2)	
Neoplasm		15 (6.1)		19 (5.5)	
Others				67 (19.4)	
External causes	154 (54.8)	88 (35.6)	80 (34.5)	165 (47.8)	159 (28.4)
Motor vehicle crashes			21 (9.0)	60 (17.4)	
Homicide	14 (5.0)	50 (20.2)	30 (12.9)	57 (16.5)	
Poisoning		13 (5.3)	16 (6.9)	23 (6.7)	
Suicide	77 (27.4)	7 (2.8)	7 (3.0)		
Others	63 (22.4)	18 (7.3)	6 (2.6)	25 (7.2)	

Data are presented as *n* or *n* (%).

proportion of deaths from external causes in Taiwan was relatively low (28%) compared with other countries (35–55%), which resulted in higher percentage of dying from direct and indirect causes, 25% and 47%, respectively.

Discussion

The findings of this nationwide population-based data linkage study indicate that 559 pregnancy-associated deaths occurred in Taiwan between 2004 and 2011. On average, ~75 women died from pregnancy-associated deaths in Taiwan per year. A J-shaped age-specific PAMR and a leveling off of age-standardized PAMR for years 2008–2009 to 2010–2011 are noted. We also found an increase in proportion of indirect causes of pregnancy-associated deaths.

In contrast to previous studies on pregnancy-associated mortality, which have been confined to one state in the United States with small number of cases, one strength of this study was the use of nationwide population-based linked data for 8 years which resulted in the largest number of cases identified. The second strength of this study was through the enhanced surveillance; this study overcame the problem of underreported maternal mortality in official published mortality data. The third strength of this study was that it was the first to examine the national PAMR trends in an Asian context.

The estimated PAMR of Taiwan (36) is lower than that in Finland (41) and in Louisiana of the United States (89), but is higher than that in Massachusetts in the United States (27) [7,9,10]. Because of the small number of pregnancy-associated deaths identified in previous studies, no study ever examined the PAMR by maternal age and years. We noted a J-shaped age-specific mortality pattern, i.e., adolescent women had a higher mortality risk than their counterparts—young women aged 20–29 year—and similar PAMR with women aged 30–34 years, but lower PAMR than women aged ≥ 35 years.

With regard to the cause of death mortality pattern, the proportion of external causes of pregnancy-associated deaths is 28% in Taiwan, which is the lowest compared with other regions, which is 55% in Finland (mainly due to suicide), 36% in Maryland in the United States, 35% in Massachusetts in the United States, and 48% in Louisiana in the United States [7–10]. In the United States, motor

vehicle crash is the leading external cause of death followed by violence. However, very few women died from violence in Taiwan.

With regard to the indirect causes (such as cardiovascular diseases or cancers), the percentage of women dying from indirect causes in Taiwan is relatively high compared with previous studies. In 2004, 12.5% of 216,362 women gave births aged ≥ 40 years. The percentage increased to 22.6% (4189/185,235) in 2011. Since more and more women with advanced age are giving birth, we are expecting to see more women with comorbidities and as a result a higher percentage of women dying from indirect causes. A study in the United States also indicated that the prevalence of severe maternal morbidity during hospitalized delivery more than doubled during 1998–2011 [12].

Several limitations should be noted in interpreting the findings of this study. Firstly, despite the identification numbers present in each data set, some pregnancy-associated deaths could not be identified because of errors in transcription, which is a common problem in administrative data sets. Secondly, the main criteria used in determining the causes of pregnancy-associated deaths were the discharge diagnoses recorded in the NHI claims data, which might be inadequate to accurately differentiate the direct and indirect causes of death. Furthermore, some external causes might not be recorded in NHI claims data.

In conclusion, compared with previous studies, the PAMR of Taiwan is moderate. However, the proportion of external causes of pregnancy-associated deaths in Taiwan is the lowest compared with other regions. Further studies (such as death review) are needed to explore possible preventable factors [13,14].

Conflicts of interest

The authors have no conflicts of interest relevant to this article.

Acknowledgments

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by the Institutional Review Board of National Cheng Kung University Hospital with the IRB number B-ER-102-120-t.

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