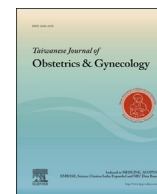




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Original Article

Underreporting of maternal mortality in Taiwan: A data linkage study



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ABSTRACT

Objective: This study examined the extent to which maternal mortality in Taiwan is underreported in officially published mortality statistics.

Materials and methods: We used National Health Insurance claims data collected from two million samples, which were linked with the officially published mortality data, to identify women aged 15–49 years, who were admitted to a hospital with pregnancy-related diagnoses during 2000–2009 and died during the pregnancy or within 42 days after the termination of pregnancy.

Results: Based on these linked data, we identified 26 maternal deaths, only nine of which were reported in the original officially published mortality data; thus, the rate of underreporting was 65% [(26 – 9)/26]. The revised maternal mortality ratio was 14.1 deaths per 100,000 live births (95% confidence interval: 8.7–19.5), which was approximately three times higher than the official reported ratio of 4.9 (95% confidence interval: 1.7–8.1). The most common cause of maternal deaths was amniotic fluid embolism ($n = 10$), followed by eclampsia and preeclampsia ($n = 4$).

Conclusion: Approximately two-thirds of the maternal deaths in Taiwan were unreported in the officially published mortality data. Hence, routine nationwide data linkage is essential to monitor maternal mortality in Taiwan accurately.

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Introduction

Maternal mortality is considered a sentinel event, reflecting access to and the quality of prenatal and obstetric care, as well as the health status of reproductive-aged women [1–3]. However, previous studies in developed countries (Austria, Canada, Finland, France, the Netherlands, UK, and USA) have indicated that officially published mortality data underreport the maternal death number [4–15]. According to officially published mortality data, the maternal mortality ratio (MMR) in Taiwan was 19 (deaths per 100,000 live births) in 1980, 12 in 1990, eight in 2000, and seven in 2008 [16]. However, according to the estimation performed by the Global Burden of Disease Study Group, the MMR for Taiwan was 38 in 1980, 26 in 1990, 12 in 2000, and 14 in 2008, approximately two times higher [17]. The only study estimating the underreporting of

maternal deaths in Taiwan was performed by Kao et al [5], who suggested that according to officially published cause-of-death statistics, the MMR was underreported by 37%. No evaluation study has been conducted in Taiwan since that of Kao et al [5] in 1997; therefore, this study was conducted to assess the extent of MMR underreporting in the 2000s in Taiwan by using National Health Insurance (NHI) claims data collected from two million samples, which was linked with the officially published mortality data.

Materials and methods

Data sources

The NHI program of Taiwan is a mandatory single-payer health insurance system in which all residents have to participate. The NHI program was implemented in 1995 and covers more than 99.5% of the Taiwanese population [18]. The NHI Research Database has been available to researchers in an electronically encrypted form since 1999. To enhance the analytical value, the NHI claims data

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collected from two million samples were linked with the officially published mortality data by the Collaboration Center for Health Information Application, Ministry of Health and Welfare, Taiwan [19]. The NHI enrollees of 2000 were proportionally sampled using 200 strata (2 for sex, 20 for age, and 6 for region). In this data set, information on each person sampled between 2000 and 2009 was retrieved from the NHI claims database. To avoid the release of personal information recorded in the NHI claims and mortality data, the linked data set was analyzed in an isolated restricted room. Only aggregated statistical tables without a single cell and with a number of counts lower than three were released after careful inspection by the Center for Health Information Application staff.

Identification of maternal deaths

The World Health Organization (WHO) defines maternal death as “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” [20]. This definition contains two components: time and causality [21]. First, we identified all women aged 15–49 years with pregnancy-related diagnoses (the International Classification of Diseases, Ninth Revision, Clinical Modification, ICD-9-CM codes 630–676 or V27) from the NHI inpatient claims data for 2000–2009. Second, based on the dates of admission and death, we determined whether the death was during pregnancy or within 42 days of the termination of pregnancy. Third, according to the WHO definition of maternal death, we excluded women who died because of external causes (accidents, suicide, or homicide).

We further classified the causes of maternal deaths into *direct* and *indirect* causes. Direct causes of death are those resulting from obstetric complications (pregnancy, labor, and puerperium), interventions, omissions, incorrect treatment, or a chain of events resulting from any of these. Indirect obstetric deaths are those resulting from a previous existing disease or a disease that developed during pregnancy and which was not due to direct obstetric causes, but which was aggravated by the physiologic effects of pregnancy [21].

Analysis

To calculate the MMR, we used the number of hospitalizations for pregnancy-related diagnoses in the sampled data set as a proxy for the number of live births. We calculated the 95% confidence intervals (CIs) for the MMR by using Poisson distribution approximation. Because of the small death number, we did not calculate the MMR stratified by maternal age strata or by the calendar years. The underreporting rate was computed as follows: (number of deaths estimated by investigators – number of deaths officially reported)/number of deaths estimated by investigators. In the officially published mortality data, we also illustrated the distribution of the causes of maternal deaths, as well as of deaths not reported as maternal deaths.

Results

According to the linked data, we identified 26 maternal deaths, only nine of which were reported in the original officially published mortality data; the underreporting rate was 65% [(26 – 9)/26]. The revised MMR was 14.1 (95% CI: 8.7–19.5), which was approximately three times higher than the officially reported MMR of 4.9 (95% CI: 1.7–8.1).

For the 26 maternal deaths identified in this study, the most common causes were amniotic fluid embolism ($n = 10$), followed by eclampsia or preeclampsia ($n = 4$) and obstetric hemorrhage ($n = 3$; Table 1). The cause of each of the nine maternal deaths reported in the original officially published mortality data was amniotic fluid embolism.

Table 2 shows a comparison of the revised and original causes of the 17 maternal deaths not reported as maternal deaths in the original officially published mortality data. We found some compatible diagnoses between the revised and original causes, such as preeclampsia or eclampsia comparable to hypertension or epilepsy, puerperal infection comparable to sepsis, and obstetric hemorrhage comparable to coagulation defects. We also noted incorrect coding for cerebrovascular disorders and cardiovascular diseases. Cerebrovascular disorders during pregnancy, childbirth, or the puerperium should be coded using the ICD-9-CM code 674.0 instead of the ICD-9-CM codes 430–434 and 436–437. Similarly, cardiovascular diseases during pregnancy, childbirth, or the puerperium should be coded using ICD-9-CM code 648.6 instead of ICD-9-CM codes 390–398 and 410–459.

Discussion

The results of this data linkage study indicate that approximately two-thirds of the maternal deaths in Taiwan were unreported in the officially published mortality data. Among the revised causes of maternal deaths, the most common cause was amniotic fluid embolism, followed by preeclampsia or eclampsia. Maternal deaths were incorrectly coded in the officially published mortality data mainly because the death certificates did not contain any pregnancy-related information.

The underreporting rate estimated in this study was 65%, which is higher than that estimated in previous studies (Table 3) and 1.8 times higher than that estimated 20 years ago in Taiwan (i.e., 37%) [5]. One possible reason for the discrepancy between the two estimated rates is that the evaluation methods used were different. In the study by Kao et al [5], public health nurses retrospectively asked the families about the deceased to verify whether the death was related to pregnancy, and based on the relevant information collected, the cause of maternal death was revised. However, in this study, only the discharge diagnoses recorded in the NHI claims data were used to define maternal deaths, and this information may be insufficient for defining maternal deaths, particularly early-pregnancy-related deaths.

Another reason for the discrepancy between the two estimated rates was that the certifying physicians in Taiwan in the 2000s were less likely to report the pregnancy status on the death certificate than those in the 1980s, as the level of litigation regarding maternal deaths was higher in the 2000s. Karimian-Teherani et al [11] suggested that countries with lower levels of litigation and higher rates of autopsies conducted for forensic reasons were associated with a

Table 1
Revised causes of maternal deaths.

Revised cause	No.	%
Direct		
Amniotic fluid embolism	10	38.5
(Pre)eclampsia	4	15.4
Obstetric hemorrhage	3	11.5
Puerperal infection	2	7.7
Indirect		
Cerebrovascular disease	3	11.5
Cardiovascular disease	3	11.5
Others	1	3.8
Total	26	100.0

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