Underregistration of neonatal deaths: an empirical study of the accuracy of infantile vital statistics in Taiwan

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Abstract

***Study objective*—The accuracy of the official statistic on infant deaths in Taiwan has been questioned. This study aimed to survey infant deaths nationwide, to measure associated vital statistics, and compare them with the official statistics to assess accuracy.**

***Design and participants*—A nationwide survey of all gestational outcomes occurring at ⩾ 20 weeks' gestation over a three day study period (15–17 May 1989) was conducted to collect data from 23 counties and cities nationwide using a two stage data collection procedure.**

***Main results*—The survey derived infant death rate was 9.72 per 1000 live births, which was higher than the reported official statistic of 5.71 per 1000 live births. A more detailed examination of data on infant deaths showed that the estimated neonatal death rate of 6.68 per 1000 live births (95% confidence intervals: 3.33, 11.96 per 1000 live births) was significantly higher than the published official statistic of 1.94 per 1000 live births, while the postneonatal mortality of 3.04 per 1000 live births was comparable to the reported statistic of 3.37 per 1000 live births.**

***Conclusions*—This study empirically documented the underregistration of infant deaths in Taiwan, particularly those occurring during the first 27 days of life.**

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The significance of infant death rate as a central vital statistic for summarising the adequacy of maternal and child health care has been well reported in the literature.[1 2] Because of their ready availability, infant death rates are routinely used for international comparisons. However, differences in the completeness of reporting newborn birth and death events among countries may have a substantial impact on reported infant death rates worldwide.[3] Additionally, large differences across countries in classifying live births and fetal deaths could also distort international infant mortality comparisons, as fetal deaths are not included in routinely reported infant death rates.[4]

There has been a steady decline in infant death rates in Taiwan in the past decades, with the reported infant death rates decreasing from 34.5 deaths per 1000 live births in 1951 to 6.4 deaths per 1000 live births in 1995.[5] With this level of infant mortality, Taiwan is one of the regions with the lowest infant death rates. Ironically, death rates during the childhood period (1–4 years of age) in the Taiwan area were not as low as but higher than those reported in most economically developed countries.[6] In addition, the pattern of infant deaths observed in Taiwan was inconsistent with the experience seen in developed countries. In the United States, for instance, approximately 63% of all infant deaths (< 1 year of age) occurred during the neonatal period (< 28 days of age) and the remaining 37% in the postneonatal period (28 days to 1 year of age),[7] whereas in Taiwan the corresponding figures were 42% and 58%, respectively, based on officially published vital statistics.[5] Taken together, these findings suggest that the official statistics of infant deaths in Taiwan may be inaccurate. We, therefore, conducted a survey of infant deaths to gauge the seriousness of this inaccuracy. This paper reports our findings.

Methods

STUDY POPULATION

With consideration to the population covered and feasibile administrative support, a three day (15–17 May 1989) study period was established to collect data on newborn vital events from the total of 23 counties and cities nationwide. The target population of this study was all gestational outcomes occurring at ⩾ 20 weeks' gestation, the same gestational age cut off used in the official statistics, during the predetermined three day study period.

DATA COLLECTION

Before the start of a full scale nationwide data collection, we had conducted a pilot study in Kaohsiung City of southern Taiwan, representating a metropolitan area, and in Nan-Tou County of central Taiwan, a rural area, to evaluate and establish an administrative system for data collection on newborn vital events.[8] Following the experience of our pilot study, a two stage data collection procedure that was integrated into the hierarchy of health care system was established. Namely, in each of the total of 23 counties and cities nationwide, a health bureau has been set up to carry out health programmes for the entire county or city. Meanwhile, at the grassroot level, one health station has been established in each township to provide basic health and medical services.[9] During the first stage of data collection, a designed birth event recording form was issued by each county and city health bureau to the medical facilities including

Table 1 Characteristics of current gestation among 1637 women who gave live births during the three day study period between 15–17 May 1989 in Taiwan

Characteristics	*Number*	*Percentage*
Plurality		
Singleton	1628	98.9
Twin	18†	1.1
Sex		
Male	888	53.9
Female	758	46.1
Gestational age (week)		
20–36	53	3.2
37–41	1460	88.7
⩾42	123	7.5
Unknown	10	0.6
Birthweight (g)		
<1500	5	0.3
1500–2500	67	4.1
>2500	1564	95.0
Unknown	10	0.6
Birth place		
Hospital/clinic	1614	98.0
Other*	32	2.0

*Includes health station, midwife's office, and domicile; †9 pairs of twins=18 newborns.

hospitals, clinics, health stations and midwife's office in the corresponding administrative area before the start of full scale data collection to record all gestational outcomes occurring at ⩾ 20 weeks' gestation during the three day study period. After receiving the completed recording forms from the corresponding medical facilities, pre-assigned administrative staff in each county and city health bureaus carefully reviewed the completeness of the recording forms and then transferred the completed forms to the corresponding public health nurses for preparations of the second stage data collection. In the second stage, the public health nurses from each health station carried out home visit questionnaire interviews one year after the dates of birth of study infants to collect data on health events pertinent to maternal and infant health during the neonatal and postneonatal period. All completed questionnaires were again carefully checked by the associated administrative staff in each health bureau. Finally, all completed recording forms and questionnaires were compiled and sent back to the research centre for data editing and analyses.

To ensure accuracy and consistency of data collection, all of the administrative staff and public health nurses received an intensive one day training before the full scale data collection. The training course included the explanation of the purpose of the study, techniques of household interview, and detailed instructions of each questionnaire item. All study flows and procedures were recorded and compiled into a field operational manual to further standardise data collection procedures.

Table 2 Study derived vital statistics of infant deaths compared with the official data in Taiwan, 1989

Component	*Number*	*Rate (per 1000)*	*95% CI**	*Official data†*
Total deliveries	1662			
Live births	1646			
Fetal deaths*	16			
Neonatal deaths*	11			
Postneonatal deaths*	5			
Neonatal death rate ((4)×1000/2)	11×1000/1646	6.68	3.33, 11.96	1.94
Postneonatal death rate ((5)×1000/2)	5×1000/1646	3.04	0.99, 7.09	3.77
Infant death rate ((4+5) ×1000/2)	16×1000/1646	9.72	5.56, 15.78	5.71

*Fetal deaths refer to deaths prior to the complete expulsion or extration from its mother of a product of conception that has had at least 20 weeks of gestation; neonatal deaths refer to infant deaths that occur during the first 27 days of life and postneonatal deaths refer to infant deaths between 28 days and 1 year of age; CI: confidence intervals derived from Poisson approximation. †The official data refer to the whole year of 1989.

ESTIMATION OF VITAL STATISTICS

The following definitions related to infant vital events were used in this study. The "fetal deaths" refers to deaths before the complete expulsion or extraction from the mother of a product of conception that has had at least 20 weeks of gestation; "neonatal deaths" refers to infant deaths that occur during the first 27 days of life; and "postneonatal deaths" refers to infant deaths between 28 days and 1 year of age. In the first stage of data acquisition, a total of 1926 birth events were reported. Of these reported events, 148 were excluded because these records were outside the pre-determined three day study period. As a consequence, a total of 1778 birth events including 1762 live births and 16 fetal death were recorded. Subsequently, in the second stage, which took place one year after the dates of birth of these 1762 live births, 1637 mothers with 1646 live births (corresponding to 1628 singleton and nine pairs of twin births) had acknowledged the vital status of their infants via questionnaire interviews. Accordingly, the denominators of the neonatal, postneonatal, and infant death rates were based on 1646 live births. The 95% confident intervals (CIs) associated with each estimated vital statistics were derived from the Poisson approximation.[10]

OFFICIALLY REPORTED VITAL STATISTICS

In Taiwan, infant births and infant deaths have to be registered by the parents or the family concerned within 15 days. Then infant vital statistics are compiled by the highest health authority, the Department of Health of the Executive Yuan, from two different administrative bodies. Data on live births are collected from the Household Registration System managed by the Department of Interior of the Executive Yuan while data on infant deaths are obtained from the Vital Registration System operated by the Provincial Department of Health. Subsequently, the Department of Health of the Executive Yuan publishes the annual report of the "Health and Vital Statistics".[5] The officially reported infant vital statistics cited in this report were abstracted from that publication.

Results

CHARACTERISTICS OF CURRENT GESTATION

There were 1637 women with 1646 live births (corresponding to 93% of the total number of live births) completed questionnaire interviews. Among them, there were 1015 (62%) multiparous (⩾ 1 previous birth) and 622 (38%) nulliparous (no previous births) women. The mean (SD) maternal age was 27.8 (4.1) for multiparous women and 25.1 (4.0) for nulliparous women. The number of women who gave birth in the three day study period, 15–17 May, was 509 (31.1%), 582 (35.6%), and 546 (33.3%), respectively. Table 1 gives

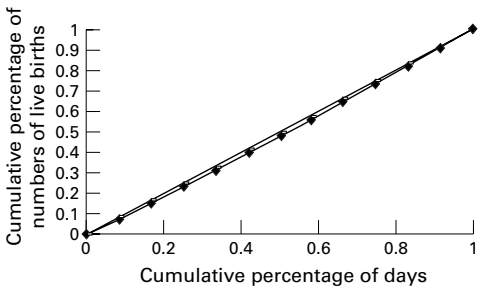

Figure 1 The Lorenz curve of the analysis of seasonal variation in numbers of live births in Taiwan, 1981–1988.

KEY POINTS

- The underregistration of neonatal deaths has a detrimental impact on reported infant death rates.
- To improve vital registration, effort must be made to adopt institutions as registration centres for all vital events occurring there.
- Comparison of infant death rates of the countries of the world requires assessment of the completeness and accuracy of data.

the characteristics of current gestation among these 1637 women. It is of note that we observed 3.2% of preterm births (defined as births before 37 completed weeks of gestation) and 4.4% of low birthweight births (births in which the infant weights $\leqslant$2500 g). In addition, most newborns (98%) were attended by qualified obstetric physicians in either hospitals or clinics and the remaining 2% of newborns were delivered in health stations or a midwife's office or at home.

COMPARISON BETWEEN STUDY DERIVED AND OFFICIALLY REPORTED INFANTILE VITAL STATISTICS

Table 2 shows the derived vital statistics of infant deaths for the Taiwan area based on birth events occurring in the three day study period and data collected from subsequent one year later follow up interviews. For comparative purpose, the officially reported vital statistics were also presented in table 2. The infant death rate derived from our survey was higher than the reported official statistic (9.72 v 5.71 per 1000 live births) in the same year[5] while the 95% CIs for the study rate extended below the officially reported rate. In addition, the estimated postneonatal death rate was comparable to the reported statistic (3.04 v 3.77 per 1000 live births). It was of note that the study derived neonatal death rate of 6.68 per 1000 live births (95% CI: 3.33, 11.96 per 1000 live births) was significantly higher than the officially reported rate of 1.94 per 1000 live births.

Discussion

The comparison between the study derived estimates and officially reported statistics suggested that the most significant factor contributing to the invalidity of reported official statistics of infant deaths in Taiwan was the serious underregistration of infant deaths occurring during the first 27 days of life. It had been recognised as early as the 1960s that gross underregistration of infant deaths, particularly in the neonatal period, was quite serious in Taiwan.[11] As described earlier, both infant births and infant deaths are mandatorily registered by the parents or the family concerned within 15 days. It is probable that the parents or the relatives of the victims report neither the birth nor the death of the victims as the death event occurred within a few days after birth when the birth had not yet been reported, as the case in Thailand.[12] In addition, infants born alive but who died shortly after might have been misclassified as fetal deaths rather than registered as neonatal deaths. These factors may contribute to a severe underreporting of the numbers of infant deaths occurring during the first 27 days of life in Taiwan.

There are differences in birth registration practices among countries throughout the world.[4] Registration of births in the United States is the responsibility of the medical profession.[4] In contrast, it has been the responsibility of the parents to register births, live or dead, in Taiwan. As discussed earlier, reliance on parents to report such vital events could result in a blatant underreporting of infant deaths, particularly those occurring during the first 27 days of life. Our study showed that most deliveries in Taiwan took place in either hospitals or clinics (98%), which was comparable with the finding made by Wu and Young (98.8%).[6] As a consequence, a registration mechanism that uses medical institutions should substantially improve coverage and timeliness of registration. The addition of a hospital-based system of reporting is undergoing a field trial in Taiwan by the Department of Health.

In terms of strength and limitations of our study, this is the first study incorporating efforts from the hierarchy of health care system to assess the underregistration of infant deaths in Taiwan. Consequently, it has revealed that the serious underestimation of infantile vital statistics in the study area is based on the empirical observation of the remarkably low rate of fetal death (9 per thousand from 20 weeks) and the significantly underregistrated neonatal death. Nevertheless, a number of limitations should be noted. Because of the need to consider the feasibility of administrative support and restricted funding, there were just three days for recruitment in this study. It is a short period for the collection of birth events, and a larger numbers of births would have increased the power of the study. In addition, there is concern about the representativeness of study samples collected in the three day period of a given month to derive appropriate vital statistics. Because of this concern, we performed an analysis of seasonal variations in the numbers of live births during an eight year period between 1981 and 1988 before the start of this study using the Lorenz curve and the associated Gini index[13] based on officially reported data on monthly numbers of live

births.[5] To construct the Lorenz curve, the incidence of live births (defined as the numbers of live births per day) for each month is first calculated. And then the months are ranked, from the lowest to the highest, according to the monthly incidences. Subsequently, the Lorenz curve is the plot of the cumulative percentage of "the numbers of live births" against the cumulative percentage of "days". Meanwhile, the Gini index is defined as twice the area between the Lorenz curve and the diagonal line. Clearly this index is between zero and one, with larger values indicating greater clustering while a smaller one indicates greater uniformity. Accordingly, the Lorenz curve is presented in figure 1 and the associated Gini index was calculated as 0.033, indicating hardly any clustering of live births in a particular month. In addition, we also analysed seasonal variations in the reported numbers of infant death and found no seasonal clustering of infant death in a given month (Gini index is 0.064). Given the findings of non-significant monthly variations in the numbers of live births and infant deaths over time, we assumed a similar uniform distribution of live births day to day and were more confident about the representativeness of vital events collected during the three day study period. Another point to be noted is that the failure of obtaining data from a proportion of subjects may increase the likelihood of underestimating infantile vital statistics if the reasons of non-response were related to infant health status. This would be the case based on our observations of small proportions of preterm (3.2%) and low birthweight (4.4%) births by international standards.[4] As a result, the actual underreporting of neonatal deaths would be more substantial than our empirical estimates.

In conclusion, the results of our empirical study suggest that there is an urgent need to improve the quality and completeness of registration of infantile vital statistics in Taiwan. Besides efforts to transfer reponsibility for registration of all hospital births and deaths (including fetal deaths) to the medical institution where the events occur, we believe that incorporating relevant training courses in completion of birth and fetal death certificates into the curriculum of medical programmes as well as exploring psychosocial incentives for registering vital events are also important.

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1 Centers for Disease Control and Prevention. Consensus set of health status indicators for the general assessment of community health status-United States. *MMWR* 1991;**40**:449–51.
2 Nersesian WA. Infant mortality in socially vulnerable populations. *Annu Rev Public Health* 1988;**9**:361–77.
3 Howell EM, Blondel B. International infant mortality rates: bias from reporting differences. *Am J Public Health* 1994;**84**:850–2.
4 Sepkowitz S. International rankings of infant mortality and the United States' vital statistics natality data collecting system- Failure and success. *Int J Epidemiol* 1995;**24**:583–8.
5 Department of Health, the Executive Yuan, Republic of China. *Health and Vital Statistics, 2. Vital Statistics*, 1951–1995.
6 Wu SC, Young CL. Study of the birth reporting system. *J Natl Public Health Assoc (ROC)* 1986;**6**:15–27.
7 Luke B, Williams C, Minogue J, *et al*. The changing pattern of infant mortality in the US: the role of prenatal factors and their obstetrical implications. *Int J Gynecol Obstet* 1993;**40**:199–212.
8 Chen LM, Sun CA, Shen MH. Evaluation of the effectiveness of maternal and child health care in Taiwan: a pilot study. *Annual project report* Taipei, Taiwan: Department of Health, 1988.
9 Department of Health, the Executive Yuan, Republic of China. *Public heath in Taiwan area, Republic of China,* 1992: 8–11.
10 Ahlbom A. *Biostatistics for epidemiologists.* Boca Raton: Lewis Publishers, 1993:55–76.
11 Chow LP. *Studies on the registration of births and infant deaths in Taiwan.* [PhD thesis]. Maryland: Johns Hopkins University, 1963.
12 Lumbiganon P, Panamonta M, Laopaiboon M, *et al.* Why are Thai official perinatal and infant mortality rates so low? *Int J Epidemiol* 1990;**19**:997–1000.
13 Lee WC. Analysis of seasonal data using the Lorenz curve and the associated Gini index. *Int J Epidemiol* 1996;**25**:426–34.