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Comparing regional neonatal mortality rates: the influence of registration of births as live born for birth weight <500 g in Taiwan

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ABSTRACT

Objective To investigate regional variation in the registration of births (still+live) as live born for birth weight <500 g and the impact on the city/county ranking of neonatal mortality rate (NMR) in Taiwan.

Design Population-based cross-sectional ecological study.

Setting 20 cities/counties in Taiwan.

Participants Registered births for birth weight <500 g and neonatal deaths in 2015–2016.

Main outcome measures City/county percentage of births <500 g registered as live born and ranking of city/county NMR (deaths per 1000 live births) including and excluding live births <500 g.

Results The percentage of births <500 g registered as live born ranged from 0% in Keelung City (0/26) and Penghu County (0/4) to 20% in Taipei City (112/558), 24% in Hsinchu County (5/21) and 28% in Hualien County (9/32). The change in city/county ranking of NMR from including to excluding live births <500 g was most prominent in Taipei City (from the 15th to the 1st) followed by Kaohsiung City (from the 18th to the 14th).

Conclusions The city/county NMR in Taiwan is influenced by variation in the registration of live born for births with uncertain viability. We recommend presenting city/county NMR using both criteria (with or without minimum threshold of gestation period or birth weight) for better interpretation of the findings of comparisons of city/county NMR.

INTRODUCTION

Comparing regional neonatal mortality rates (NMR) is the most commonly used method to identify the health problems and to assess the quality of maternal and child care of a particular region. However, scholars have reminded of ensuring the true 'like for like' comparison.[1–4] Studies in Canada, the UK and the USA have shown regional variations in registration of live born for previable or periviable births and their associations with infant or neonatal death rates.[5–17] However, no study has been performed in Asian countries. Taiwan is an East Asia country showing drastic decline in total fertility rate, from 1.770 in 1997 to 1.125 in 2017, which was the lowest one among 195 countries and territories in 2017.[18 19]

According to the Taiwan government report, the percentage of births (still+live) for birth weight less than 500 g increased from 0.39% (848/217 386) in 2004 to 0.58% (1207/207 837) in 2016 (online supplementary table 1).[20] Furthermore, the percentage of births registered as live born for birth weight <500 g also increased from 7.7% (65/848) in 2004 to 10.0% (121/1207) in 2016 (online supplementary table 2).[20] However, little is known on regional variations in the registration of births as live born for birth weight <500 g and their impact on the regional ranking of NMR in Taiwan.

In Taiwan, the criteria of live birth followed the definition set by the WHO as 'the complete expulsion or extraction from its mother of a product of conception, irrespective of the duration of the pregnancy, which, after such separation, breathes or shows any other evidence of life—for example, beating of the heart, pulsation of the umbilical cord or definite movement of voluntary muscles—whether or not the umbilical cord has been cut or the placenta is attached. Each product of such a birth is considered live born.'[21] Theoretically, healthcare providers in every city/county in Taiwan use the same definition of live birth. Realistically, as indicated by Joseph *et al*, several factors will affect the registration of live birth for these previable or periviable births, such as financial compensation and healthcare culture.[4] We sought in this study to investigate city/county variation in percentage of births registered as live born for birth weight <500 g and compare the city/county ranking of NMR including versus excluding live births <500 g in

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2015–2016. We hypothesise that the percentage of live born registration for birth weight <500 g will be higher in cities than in counties. Cities are more urbanised than counties and have more level 3 medical centres with neonatal intensive unit (NICU), therefore are more likely to register births <500 g as live born.

METHODS

Data source

City/county data on registered births (still+live) and neonatal deaths (death before 28 days of life) in Taiwan for 2015–2016 were obtained from open government data: Birth Report System (https://olap.hpa.gov.tw) and Mortality Data System (https://dep.mohw.gov.tw/DOS/cp-2519-3480-113.html), respectively.[20 22] In Taiwan, all healthcare providers who delivered the babies are mandatory to report the birth-related information to Birth Report System regulated by the Administration of Health Promotion, Ministry of Health and Welfare.[20]

Patient and public involvement

This study used government open data and patients were not directly involved in the design of this study.

Analysis

There are five categories for gestational weeks (<28 weeks, 28–31 weeks, 32–36 weeks, 37–41 weeks and >41 weeks) and 11 categories for birth weight (<500 g, 500–999 g, 1000–1499 g, 1500–1999 g, 2000–2499 g, 2500–2999 g, 3000–3499 g, 3500–3999 g, 4000–4499 g, 4500–4999 g, ≥5000 g). Because of more detail of information for birth weight categories, we thus used birth weight cut-offs for viability in this study.

As the number of births <500 g which have been registered as live born increased prominently in 2015 and 2016 (online supplementary table 2) and some cities/counties had relatively small number of births for birth weight less than 500 g, we therefore combined the 2 years' data together in calculating the percentage of births <500 g registered as live born in each city/county. Following previous studies,[5–9 16] we compared the city/county ranking of NMR including versus excluding live births <500 g. To test if cities had higher percentage of live born registration than counties, we listed the population density (population per km^2) of each city/county as indicator of urbanisation level. Map and ranking slopegraph were used to illustrate the results in dashboard which can be accessed athttps://public.tableau.com/profile/robert.lu#!/vizhome/neonatalmortalityrate/Story. The users can move the cursor to a particular city/county and the percentage of births <500 g registered as live born will pop out.

RESULTS

A huge city/county variation in percentage of births <500 g registered as live born was noted (table 1 and figure 1). There were three cities/counties with percentage larger than 20%, that is, 28% in Hualien County (9/32), 24% in Hsinchu County (5/21) and 20% in Taipei City (112/558). On the contrary, there were seven cities/counties with percentage less than 5%. No birth <500 g has been registered as live born in Keelung City (0/26) and Penghu County (0/26). We did not find an association between city/county percentage of births <500 g registered as live born and city/county population density (table 1).

The range of city/county NMR including live births <500 g was 3.27 deaths per 1000 live births, from 1.56 in Changhua County to 4.82 in Hualien County. The range decreased to 2.95 if we excluded live births <500 g, from 0.88 in Taipei City to 3.83 in Pingtung County (table 1 and figure 2). The change in city/county ranking of NMR was most prominent in Taipei City (from the 15th to the 1st) followed by Kaohsiung City (from the 18th to the 14th).

DISCUSSION

The findings of this study indicate a huge regional variation in percentage of births registered as live born for periviable babies and had a great impact on regional ranking of NMR. Our hypothesis was not supported, that is, the percentage of registration of live born for periviable babies in cities was not higher than the percentage in counties. However, metropolitans (such as Taipei City and Kaohsiung City) with relatively higher percentage and larger number of periviable babies which have been registered as live born would have greater change in ranking of NMR.

Series of studies in Canada have indicated provincial variation in registration of live born for birth weight <500 g and associated with variation in ranking of provincial infant mortality rates.[5–10] For example, the registration of live births less than 500 g and less than 24 weeks of gestation was more meticulous in Alberta than elsewhere in Canada, which resulted in an increase in infant mortality rate in Alberta.[10]

Two UK studies indicated higher proportion of very preterm infants registered as live born and transferred to NICU in Trent, UK, compared with those in Nord Pas-de-Calais, France, and New South Wales/the Australian Capital Territory, Australia, was the main reason for higher NMR in Trent. The authors reminded that information about very preterm babies (not usually included in routine statistics) is vital to avoid inappropriate interpretation of international perinatal and infant data.[11 12]

A study in the USA investigated the state-level variations in the classification of live birth or fetal death would be reflected in the fetal and infant mortality rates for this birth weight group. The findings of that study suggested that six states were more likely to classify outcomes as a live birth/infant death, while 14 states were more likely to classify as a fetal death, when compared with a large reference state. The authors concluded that fetal death

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Table 1 Percentage of births (still+live) registered as live born for birth weight <500 g and neonatal mortality rate (NMR) including (NMR1) and excluding (NMR2) live births <500 g by region in Taiwan, 2015–2016

Region	Population density*	Births <500 g	Registered as live born	%	Neonatal deaths 1	NMR1	Neonatal deaths 2	NMR2
Taiwan	653	2527	257	10.2	1044	2.50	787	1.88
Hualien County	72	32	9	28.1	26	4.82	17	3.15
Hsinchu County	382	21	5	23.8	26	2.35	21	1.90
Taipei City	9935	558	112	20.1	162	2.86	50	0.88
Pingtung County	302	24	4	16.7	44	4.21	40	3.83
Kaohsiung City	941	301	41	13.6	151	3.42	110	2.49
Miaoli County	308	25	3	12.0	17	1.63	14	1.35
Changhua County	1199	138	15	10.9	42	1.56	27	1.00
Yunlin County	540	20	2	10.0	23	2.36	21	2.15
Taitung County	63	12	1	8.3	8	2.55	7	2.23
New Taipei City	1937	189	14	7.4	181	2.58	167	2.38
Chiayi County	272	31	2	6.5	18	3.02	16	2.68
Hsinchu City	4183	89	5	5.6	29	3.06	24	2.53
Nantou County	124	20	1	5.0	19	2.65	18	2.51
Chiayi City	4500	43	2	4.7	11	2.50	9	2.04
Taoyuan City	1742	366	17	4.6	95	2.05	78	1.69
Taichung City	1244	358	16	4.5	105	2.03	89	1.72
Tainan City	860	226	7	3.1	57	1.88	50	1.65
Yilan County	214	44	1	2.3	17	2.45	16	2.31
Keelung City	2803	26	0	0.0	8	1.61	8	1.61
Penghu County	810	4	0	0.0	5	2.61	5	2.61

*Population per km^2 as indicator of urbanisation.

and early infant death outcomes reported for babies less than 500 g reflect differential classification, thus influencing the validity of these vital statistics data at the state level.[13] Another US study further indicated that the birth hospital was an important predictor of whether the death was classified as a fetal or infant death. Among the 31 hospitals selected for study, there was a nearly 15-fold variation in the probability of events being classified as early neonatal versus fetal death.[14]

A recent US study assessed county-level variation in death event reporting at 17–20 weeks of gestation and associations with county infant mortality rates. Of 2391 counties studied, the percentage of deaths at 17–20 weeks reported as fetal ranged from 0% to 100% (mean 63.7%) and every 1 point increase in this percentage was associated with a 0.02 point decrease in county infant mortality rate. The authors suggested that the variation in the reporting of previable gestation deaths likely reflects a combination of legislative policy and hospital practices, cultural norms in attitudes towards pregnancy termination and neonatal resuscitation, as well as social, economic and religious views.[15]

A study of 147 primary care trusts (PCT) in England indicated wide between-PCT variation in percentages of births <24 weeks of gestation registered as live born with 90% central range from 26.3% to 79.5%. Excluding births <24 weeks led to significant changes in infant mortality rankings of PCTs, with a median worsening of 12 places for PCTs with low rates of live born preterm births <24 weeks of gestation compared with a median improvement of four ranks for those with higher live birth registration rates.[16]

The findings of this study are consistent with the findings of study in England. We noted prominent improvement in ranking of NMR after excluding live births <500 g in thee largest metropolitans (Taipei City and Kaohsiung City). The two cities had relatively higher percentage and larger number of births <500 g registered as live born and consequently had a greater impact on ranking of NMR after excluding the live birth <500 g. We also identified several cities/counties showing relatively large increase in number of reporting live births <500 g in 2015 or 2016. Future research is needed to explore the possible reasons of the increase.

One possible explanation that our hypothesis was not supported was that many pregnant women with possible periviable births who resided in counties (eg, Nantou County, Miaoli County or Changhua County) nearby Taichung City (figure 1) might go to level 3 medical centres with NICUs in Taichung City for deliveries. These

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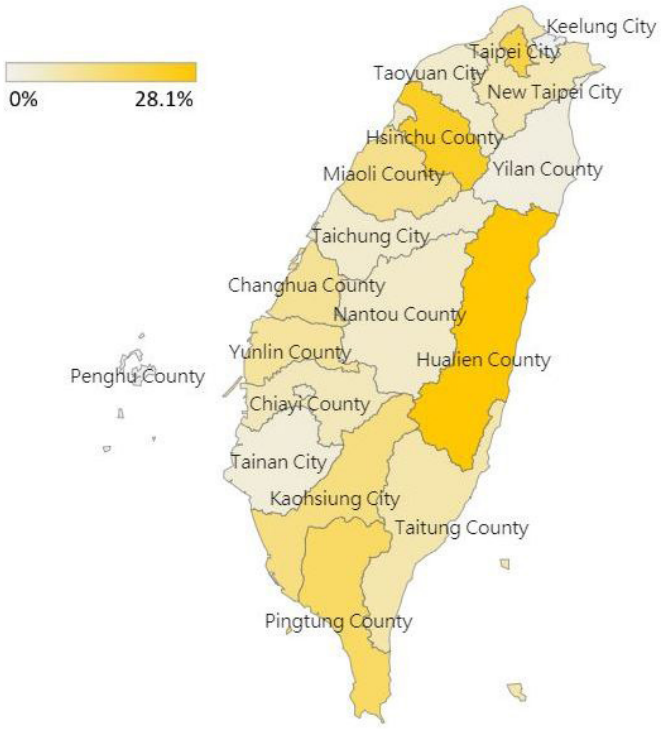

Figure 1 Percentage of births (still+live) registered as live born for birth weight <500 g in each city/county in Taiwan, 2015–2016, https://public.tableau.com/profile/robert.lu#!/vizhome/neonatalmortalityrate/Story.

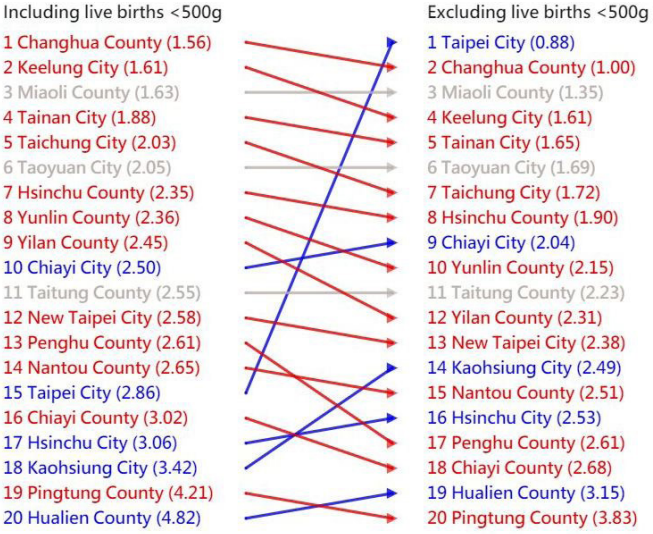

Figure 2 Changes in city/county ranking of neonatal mortality rate (deaths per 1000 live births) including and excluding live births <500 g in Taiwan, 2015–2016 (blue line indicates improving of ranking and red line indicates worsening of ranking), https://public.tableau.com/profile/robert.lu#!/vizhome/neonatalmortalityrate/Story.

births were still registered in the counties in which these women resided. Further studies are needed to examine the variation in birth hospitals in Taiwan.

To better interpret the findings of international comparisons of infant and NMR in the fact of regional variations in reporting live births <22 weeks' gestation or <500 g birth weight across countries, the OECD Stat presents both criteria, that is, 'no minimum threshold of gestation period or birth weight' and 'minimum threshold of 22 weeks or (500 g birth weight)'.[23] The findings of this study also reveal large variation in percentage of reporting live births <500 g across cities/counties in Taiwan. We thus recommend presenting the infant and NMR using both criteria and let the readers have more information in interpretation of the findings of the comparisons.

Several limitations should be noted while interpreting the findings of this study. First, this is an ecological study, we did not take into account the associated factors affecting the city/county NMR. Second, the information on birth hospital that delivered the periviable babies was not available. We thus could not determine how many births <500 g registered as live born in counties were actually delivered in level 3 medical centres in the cities. We also could not detect if the behaviour of registration of live born for births <500 g in some cities/counties was concentrated in particular hospitals. Third, this is not a survey study, we could not understand the real reasons in some healthcare providers having higher percentage of registration of live born for births <500 g. Fourth, the regional variation in registration of live born would be influenced by the regional variation in determination of stillbirth. However, the information on the stillbirth on parents at earlier gestations or whether the stillbirth was due to termination of pregnancy in each city/county was not available in Birth Report System open government data.

CONCLUSIONS

Despite the aforementioned limitations, this ecological study illustrates the huge regional variation in the registration of live born for births with uncertain viability, which would affect the comparability of NMR. We recommend presenting city/county NMR using both criteria (with or without minimum threshold of gestation period or birth weight) for better interpretation of the findings of comparisons of city/county NMR. Further studies are needed to identify hospitals having higher or lower percentage of registration of live born and to understand the reasons behind. The information is relevant to improve the consensus on guidelines for these periviable births.

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What is known about the subject?

- Studies have shown regional variations in registration of live born for periviable babies and impacts on regional infant or neonatal mortality rates (NMR).
- However, little is known on this comparability problem in Asian countries.

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What this study adds?

- Huge variations exist in registration of live born for births <500 g between cities/counties in Taiwan.
- Variation in registration practices impacts greatly on the ranking of regional NMR in Taiwan.
- It is recommended to present city/county NMR using both criteria for better interpretation of the findings of comparisons of city/county NMR.

Contributors LYW and THL conceived the study, guided the analyses and wrote the article draft. YSC and FWL collected and analysed the data. YCL, YJL and CHL critically revised the draft. LYW and THL were the guarantors of the study.

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