

Lower early neonatal mortality among singletons in transnational marriage families: Taiwan Birth Registry

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Received: 20 November 2006 / Accepted: 8 April 2008 / Published online: 25 April 2008
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Abstract The nativity composition of the Taiwan population has changed substantially since 1980, which resulted in one in six children being born to foreign-born mothers in 2004. The purpose of this study was to compare the early neonatal mortality rates among babies of foreign-born and Taiwan-born mothers. Data was obtained from the Taiwan Birth Registry Database in 2004 by the Bureau of Health Promotion, Department of Health, Taiwan. Multivariate analysis was used to examine the influence of the different maternal nationalities on early neonatal mortality after adjusting for important maternal and infant variables. Infants born to foreign-born mothers had a lower early neonatal mortality rate (5.6‰) compared to those born to Taiwan-born mothers (9.4‰). Even after adjusting for important maternal and infant variables, newborns of foreign-born mothers still had a lower risk of early neonatal death compared to newborns of Taiwan-born mothers (odds ratio = 0.68, 95% CI = 0.57–0.80). Foreign-born status may serve as an important index of differentiation in early neonatal mortality among the current Taiwan population. Selection, economic and non-economic aspects may explain the paradox of favorable early neonatal mortality outcomes.

Keywords Early neonatal mortality · Transnational marriage · Foreign-born mothers · Risk factors

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Introduction

Neonatal and infant mortality are important indices of a community's health and social well-being [1]. It is well-understood that a quarter of pediatric deaths occur during the first week after birth [2]. When making international comparisons in maternal and child health, immigrant groups contribute far more complicated effects on neonatal mortality, even after adjusting for maternal health, labor and delivery complications [3].

Much attention has focused on the health of immigrants' newborns. Surprisingly, newborns of foreign-born mothers seem to display a significantly lower neonatal mortality and infant mortality than their origin-born counterparts in the US and England, even after a number of sociodemographic risk factors have been controlled [1, 4–7]. Such paradoxically favorable outcomes in newborns of immigrants denote a residual protective effect of foreign-born status that cannot be accounted for demographic, socioeconomic, behavioral or medical risk factors [8].

The nativity composition of the Taiwan population has changed substantially since 1980, which resulted in one in six children being born to foreign-born mothers in 2004 [9]. The nature of transnational marriage in Taiwan is different from that of immigrants who seek jobs in developed countries. Many Taiwanese husbands who are married to foreign women are either physically or mentally handicapped, or live in rural areas or near the border of metropolitan areas. Foreign women who are married to a Taiwanese man and reside in Taiwan generally come from lower-class families in developing or underdeveloped countries. These transnational foreign brides are mostly chosen by marriage brokers and their marriages are usually defined as traded marriages [10]. To obtain a residential

visa to Taiwan, these foreign brides must pass a physical exam and their health status is just as good as that of Taiwanese women.

In 2004, information of maternal nationality was required in the birth record in hopes that the birth registry could provide raw material to uncover the extent and sources of variation of maternal nationality and to explore their influence on birth outcome. The purpose of this study was to compare early neonatal mortality among newborns of foreign-born and Taiwan-born mothers univariately and multivariately using the 2004 Taiwan Birth Registry.

Methods

The data for our study was obtained from the Taiwan Birth Registry, Bureau of Health Promotion, Department of Health in Taiwan. Live singletons born in 2004 were included in this study. Live birth is defined as an infant with a gestational age exceeding 20 weeks and vital signs such as respiration, heartbeat, pulsation of umbilical cord and muscular movements right after birth. Neonatal deaths are usually categorized into early neonatal deaths that occur during the first seven days of life (0–6 days) and late neonatal deaths that occur between the seventh and 28th days of life (7–27 days) [3]. In this study, neonatal mortality was defined as the death of a newborn during the first 10 days of life because births are registered in the first ten days of life in Taiwan. In this study, women from Southeast Asia or mainland China were considered foreign-born mothers. Foreign-born mothers from developed countries such as Japan, Korea, South Africa, England, America, etc. (0.21%) were not included in this study.

Variables in the Taiwan Birth Registry include: (1) newborn: gender, gestational age, birth weight, time and date of birth, number of parturition, location of the delivery center, status of birth (alive or dead) and other health problems; (2) mother: date of birth, nationality, address, risk factors of the pregnancy and interventions during pregnancy; (3) delivery: deliverer of the baby (physician or midwife), delivery method and labor complications. Risk factors of the pregnancy include the following: anemia (hematocrit < 30 or hemoglobin < 10), cardiac disease, pulmonary disease, diabetes mellitus, syphilis, gestational diabetes, hydramnion (AFI \geq 24 cm or DP \geq 8 cm) or oligohydramnion (AFI \leq 5 cm or DP \leq 1 cm), hemoglobinopathy, chronic hypertension, gestational hypertension, toxemia of pregnancy, cervical incompetence, previous delivery of an overweight infant (birth weight \geq 4000 g), previous delivery of a preterm (gestational age < 37 weeks) or low birth weight baby (birth weight < 2500 g), nephropathy or Rh factors anaphylaxis. Interventions during pregnancy and labor include amniocentesis, chorionic

villus sampling, induction and stimulation of labor, tocolysis, cervix cerclage procedure, exploratory laparotomy (hysteromyomectomy or ovarian cyst removal) and others. Complications of labor include fever of the mother (temperature > 38°C), meconium-stained amniotic fluid (moderate/severe), rupture of water bag (>12 h), premature detachment of placenta, placenta praevia, other hemorrhage (vaginal delivery >500 ml, cesarean section >1000 ml), convulsion of labor, precipitated labor (<3 h), prolonged labor (regular uterine contractions >20 h), difficult labor progress, breech presentation/malpresentation, cephalopelvic disproportion, umbilical cord prolapse, complications of anesthesia, fetal distress and others. In Taiwan, information regarding the pregnancy or delivery is filled out by obstetricians, and information for the newborn is filled out by pediatricians. Hospitals or clinics are obligated to report a birth and provide the above information to the local health department within 10 days of a baby's delivery.

As preterm and/or low birth weight is an indirect cause of neonatal deaths, grouping birth weight by gestation age (BWGA) is usually done to avoid confounding effects on birth outcome [11]. BWGA is separated into three categories: small for gestation age (SGA), when the newborns' birth weight is below the 10th percentile; appropriate for gestation age (AGA), when the newborns' birth weight is between the 10th and 90th percentile; and large for gestation age (LGA), when the newborns' birth weight is above the 90th percentile [12]. Gestational age in completed weeks was computed from the interval between the first day of the last menstrual period (LMP) and the date of birth. Records that lacked the date of the LMP were imputed when there was a valid month and year. Clinical estimates through ultrasound were used to estimate gestational age in cases where the date of the LMP was not reported or where the LMP date was inconsistent with the birth weight [13].

Statistical analysis

Early neonatal mortality in permillage (‰) along with 95% confidence interval (CI) for Taiwan-born mothers and foreign-born mothers was computed, respectively. The Chi-square test or Fisher's exact test was used to examine the effects of the pregnancy and labor and delivery characteristics on early neonatal mortality univariately. Logistic regression with forward selection was done to determine which variables were associated with neonatal mortality multivariately, and the adjusted effect of maternal nationality on neonatal mortality was calculated. Odds ratios (OR) with 95% CI were used to estimate the relative risk of a factor on early neonatal death. The significance level of this study was 0.05.

Results

In 2004, there were 213,049 live births of singletons in Taiwan, among which 86.3% were from Taiwan-born mothers and 13.7% were from foreign-born mothers. The early neonatal mortality for Taiwan-born mothers was 9.4‰, and was significantly higher than that among foreign-born mothers (5.6‰). The only exception was the Philippines, where the early neonatal mortality among foreign-born mothers in Taiwan was significantly lower than that in original country [3] based on the coverage of their 95% CI (Table 1).

Since early neonatal death was associated with maternal age [14] and BWGA [12], early neonatal mortality was plotted against maternal age and BWGA for the two mother groups (Table 2 and Figs. 1, 2). A U-shaped relationship between early neonatal mortality and maternal age was seen. Neonatal mortality was highest in babies of the SGA group, followed by the LGA groups or the AGA groups. More importantly, early neonatal mortality remained significantly lower in foreign-born mothers than in Taiwan-born mothers for each maternal age group, except for maternal age ≥ 35 . Significant differences in neonatal mortality for the AGA group were evident between Taiwan-born and foreign-born mothers.

Besides maternal age and nationality, health condition and delivery characteristics of the pregnant mothers were univariately associated with early neonatal death as well. Among the pregnant risk factors, early neonatal mortality was significantly higher than its corresponding absent group and the rate ranked the highest in babies with cervical incompetence (232.9‰), followed by hydramnion or oligohydramnion (111.5‰), chronic hypertension (96.9‰), Rh factors anaphylaxis (80.0‰), nephropathy (66.7‰), diabetes mellitus (44.7‰), mothers who

Table 2 Early neonatal mortality by maternal age and birth weight for gestational age grouping in Taiwan, 2004

	Total death (‰)	Taiwanese death (‰)	Foreign death (‰)	P
Total	1891 (8.9)	1,727 (9.4)	164 (5.6)	<0.0001
Maternal age				
<20	113 (15.3)	99 (17.8)	14 (7.6)	0.0020
20–24	344 (7.5)	280 (8.7)	64 (4.8)	<0.0001
25–29	600 (7.5)	548 (7.7)	52 (5.7)	0.0310
30–34	501 (8.5)	479 (8.7)	22 (5.7)	0.0530
≥ 35	333 (15.8)	321 (16.0)	12 (11.6)	0.2638
Birth weight for gestational age				
SGA	332 (15.8)	297 (16.3)	35 (12.8)	0.1716
AGA	1383 (8.1)	1274 (8.6)	109 (4.6)	<0.0001
LGA	176 (8.4)	156 (8.6)	20 (7.4)	0.5284

SGA: small for gestational age

AGA: appropriate for gestational age

LGA: large for gestational age

previously delivered a preterm or a low birth weight baby (41.9‰), toxemia of pregnancy (28.0‰), anemia (20.7‰) and gestational hypertension (20.1‰) (Table 3).

In our analysis of delivery complications, a significantly higher early neonatal mortality was seen in babies with umbilical cord prolapse (132.4‰), premature detachment of placenta (58.9‰), or in mothers with fever (50.6‰), prolonged rupture of water bag (36.2‰), hemorrhage due to either vaginal delivery or cesarean section (27.2‰), breech presentation/malpresentation (15.8‰), univariately. Lower early neonatal mortality was seen in mothers with precipitated labor (4.8‰), difficult labor progress (2.1‰),

Table 1 Early neonatal mortality by maternal nationality in Taiwan, 2004

Maternal nationality	N	Taiwan			Original country ^a	
		Deaths	‰	95% CI	‰	Year
Taiwanese	183,913	1,727	9.4	8.9–9.8		
Foreign	29,136	164	5.6	4.7–6.4		
Thailand	330	1	3.0	1.1–4.9	9	1987, 1993
Myanmar	218	1	4.6	1.2–25.3	30	1997, 1991
Mainland China	11,329	56	4.9	3.6–6.2	16	1994
Vietnam	13,212	74	5.6	4.3–6.9	13	1997
Cambodia	767	5	6.5	0.8–12.7	31	2000
Indonesia	2,792	19	6.8	3.8–9.8	33	1998–1999
Philippines	488	8	16.4	5.1–28.7	12	1995–1996

^a Adopted from the perinatal mortality by WHO 3

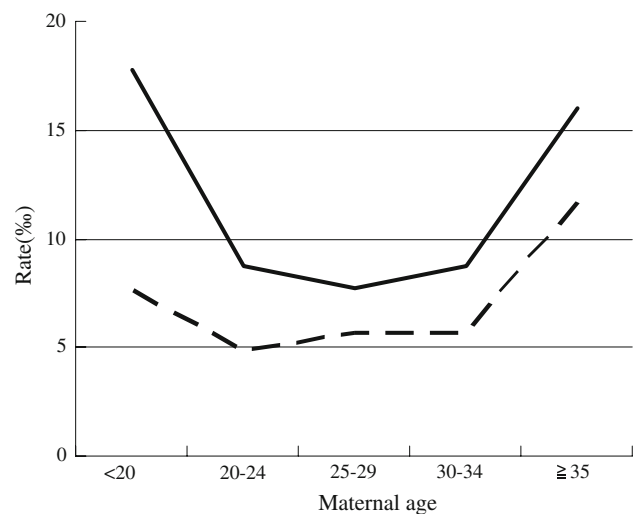


Fig. 1 Early neonatal mortality versus maternal age by maternal nationality in Taiwan, 2004 (Solid and broken lines represent early neonatal mortality for the birth of Taiwan-born and foreign-born mothers, respectively.)

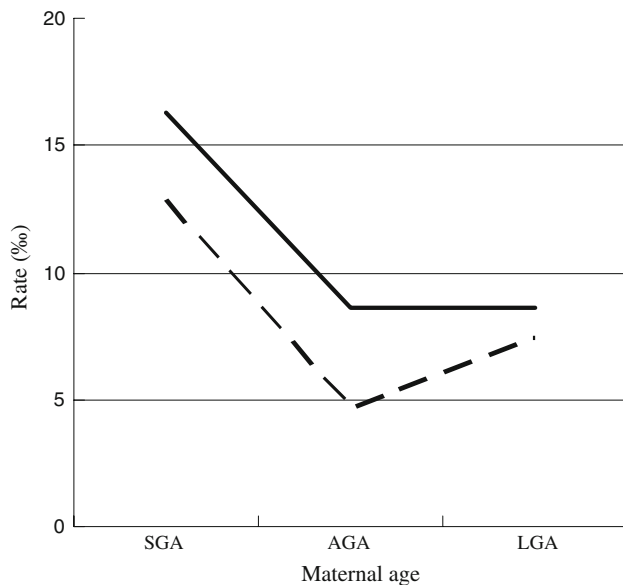


Fig. 2 Early neonatal mortality versus gestational age birth weight by maternal nationality in Taiwan, 2004 (Solid and broken lines denote early neonatal mortality for Taiwan-born and foreign-born mothers, respectively) SGA: small for gestational age AGA: appropriate for gestational age LGA: large for gestational age

prolonged labor (1.6%), univariately. For mothers who received health intervention during pregnancy and labor, induction (285.5%), chorionic villus sampling (79.4%), cervix cerclage procedure (55.6%), tocolysis (39.7%), amniocentesis (31.0%) and exploratory laparotomy (19.4%) were significantly associated with a higher early neonatal mortality compared to mothers who did not receive the corresponding health intervention during pregnancy and labor, univariately (Table 4).

To examine whether the effect of maternal nationality on early neonatal mortality still existed multivariately, multiple logistic regression was performed. Most variables that were significantly associated with early neonatal mortality univariately remained significantly associated with early neonatal mortality multivariately, except for gestational hypertension, toxemia of pregnancy, cervical incompetence, nephropathy, Rh factors anaphylaxis, other hemorrhage and exploratory laparotomy. More importantly, after adjusting for maternal age, BWGA, risk factors of pregnant mother, delivery complications, health interventions during pregnancy and labor, newborns of foreign-born mothers were less likely to die in the first ten days of birth than were newborns of Taiwan-born mothers with an odds ratio of 0.675 (95% CI = 0.570–0.799) (Table 5).

Discussion

Using 2004 data from the Taiwan Birth Registry Database to compare the early neonatal mortality rate between

Table 3 Univariate analysis of the influence of pregnancy risk factors on early neonatal mortality in Taiwan, 2004

	Early-neonatal mortality rate (‰)	P
Cervical incompetence	34 (232.9)	<0.0001
Hydramnion (AFI \geq 24 cm or DP \geq 8 cm) or oligohydramnion (AFI \leq 5 cm or DP \leq 1 cm)	58 (111.5)	<0.0001
Chronic hypertension	19 (96.9)	<0.0001
Rh factors anaphylaxis	2 (80.0)	0.0206
Nephropathy	5 (66.7)	<0.0001
Diabetes mellitus	11 (44.7)	<0.0001
Had delivered a preterm (gestational age < 37 weeks) or a low birth weight baby (birth weight <2500 g) before	22 (41.9)	<0.0001
Toxemia of pregnancy	26 (28.0)	<0.0001
Syphilis	3 (21.6)	0.0833
Pulmonary disease	2 (21.3)	0.2033
Anemia (hematocrit <30 or Hemoglobin <10)	29 (20.7)	<0.0001
Gestational hypertension	23 (20.1)	<0.0001
Cardiac disease	5 (19.5)	0.0795
Had delivered an over-weighted (birth weight \geq 4000 gms) before	3 (16.3)	0.2248
Gestational diabetes	14 (12.3)	0.2129
Hemoglobinopathy	0 (0.0)	1.0000
Other	30 (33.5)	<0.0001

foreign-born and Taiwan-born mothers, we found that newborns of foreign-born mothers were less likely to die in the first ten days of birth compared to newborns of Taiwan-born mothers, univariately. Even after the maternal age and BWGA were stratified, early neonatal mortality in foreign-born mothers was still lower than that in Taiwan-born mothers. Furthermore, multiple logistic regression revealed a significant protective effect in early neonatal death among newborns of foreign-born mothers compared to those of Taiwan-born mothers after adjusting for important factors such as delivery complications and health interventions during pregnancy and labor. Prior studies suggest that selection, economic and non-economic pathways may explain the unexpectedly favorable health outcomes of newborns among immigrants [15].

A possible cause of the selection effect on better health outcomes in newborns could be explained by the “healthy migrant theory” [16]. According to the healthy migrant theory, healthier people who are more able to migrate and be mobile generally have better birth outcomes than those who do not move. To explore whether selection can explain lower early neonatal mortality in foreign-born mothers, we listed the early neonatal mortality with its 95% CI by maternal nationality in Taiwan in our study and the

Table 4 Univariate analysis of delivery characteristics on early neonatal mortality in Taiwan, 2004

	Early-neonatal mortality rate (‰)	P
<i>Complication of delivering</i>		
Umbilical cord prolapse	9 (132.4)	<0.0001
Premature detachment of placenta	47 (58.9)	<0.0001
Fever of the mother (temperature > 38°C)	26 (50.6)	<0.0001
Convulsion of labor	1 (40.0)	0.1998
Rupture of water bag (>12 h)	114 (36.2)	<0.0001
Other hemorrhage (vaginal delivery >500 ml, cesarean section >1000 ml)	21 (27.2)	<0.0001
Breech presentation/malpresentation	135 (15.8)	<0.0001
Placenta praevia	20 (12.8)	0.0978
Meconium stained amniotic fluid (moderate/severe)	37 (10.9)	0.2086
Fetal distress	28 (10.3)	0.4389
Precipitated labor (<3 h)	17 (4.8)	0.0097
Difficult labor progress	9 (2.1)	<0.0001
Prolonged labor (regular uterine contraction >20 h)	4 (1.6)	<0.0001
Complications of anesthesia	0 (0.0)	1.0000
Cephalopelvic disproportion	0 (0.0)	1.0000
Others	46 (41.3)	<0.0001
<i>Health interventions of pregnancy and labor</i>		
Induction of labor	340 (285.5)	<0.0001
Chorionic villus sampling	5 (79.4)	<0.0001
Cervix cerclage procedure	10 (55.6)	<0.0001
Tocolysis	111 (39.7)	<0.0001
Amniocentesis	117 (31.0)	<0.0001
Exploratory laparotomy (hysteromyomectomy or ovarian cyst removal)	3 (19.4)	0.1600
Stimulation of labor	86 (6.0)	0.0002
Others	6 (53.1)	<0.0001

early neonatal mortality of the country of origin by literature search. With the exception of the Philippines, the early neonatal mortality of newborns in foreign-born mothers who resided in Taiwan, such as women from Thailand, Myanmar, mainland China, Vietnam, Cambodia and Indonesia, and Thailand, was lower than in their countries of origin as well as in Taiwan-born groups. Since most foreign-born brides have good health, education, similar cultural background as Taiwan due to selection by marriage brokers, and have passed the physical examination required by the Ministry of Foreign Affairs, selection is one good explanation of the low early neonatal mortality in foreign-born mothers.

Table 5 Logistic regression on early neonatal mortality in Taiwan, 2004

	Odds ratio	95% CI	P
<i>Nationality</i>			
Taiwan	1	Reference	–
Foreign	0.675	0.570–0.799	<0.0001
<i>Birth weight for gestational age</i>			
SGA	1.879	1.654–2.136	<0.0001
AGA	1	Reference	–
LGA	1.003	0.849–1.183	0.9763
<i>Maternal age</i>			
<20	2.172	1.757–2.685	<0.0001
20–24	1.147	0.998–1.318	0.0530
25–29	1	Reference	–
30–34	1.039	0.917–1.177	0.5495
≥35	1.748	1.507–2.027	<0.0001
<i>Risk factors of the pregnant mother</i>			
Cervical incompetence	35.755	20.647–61.917	<0.0001
Hydramnion (AFI ≥ 24 cm or DP ≥ 8 cm) or oligohydramnion (AFI ≤ 5 cm or DP ≤ 1 cm)	3.689	2.576–5.283	<0.0001
Chronic hypertension	3.604	2.019–6.436	<0.0001
Diabetes mellitus	2.316	1.157–4.638	0.0177
Anemia (hematocrit <30 or Hemoglobin <10)	1.538	1.006–2.353	0.0471
Others	2.199	1.449–3.338	0.0002
<i>Health interventions of pregnancy and labor</i>			
Induction of labor	50.344	43.498–58.267	<0.0001
Chorionic villus sampling	5.143	1.835–14.416	0.0018
Amniocentesis	2.180	1.746–2.722	<0.0001
Tocolysis	1.744	1.359–2.237	<0.0001
Stimulation of labor	0.632	0.504–0.791	<0.0001
Cervix cerclage procedure	0.194	0.078–0.480	0.0004
Others	2.648	1.074–6.529	0.0345
<i>Complication of delivering</i>			
Umbilical cord prolapse	7.130	2.962–17.165	<0.0001
Premature detachment of placenta	4.464	3.176–6.273	<0.0001
Rupture of water bag (>12 h)	2.850	2.255–3.601	<0.0001
Fever of the mother (temperature >38°C)	2.798	1.733–4.519	<0.0001
Breech presentation/malpresentation	1.456	1.203–1.763	0.0001
Precipitated labor (<3 h)	0.500	0.305–0.819	0.0059
Difficult labor progress	0.144	0.073–0.282	<0.0001
Prolonged labor (regular uterine contraction > 20 h)	0.132	0.048–0.360	<0.0001
Others	4.145	2.977–5.770	<0.0001

Economic pathway, which primarily depends upon access to maternal health care during pregnancy and delivery, is the next concern [17–20]. National Health Insurance in Taiwan (NHIT) contributes a significant amount, which impacts the health of newborns. All expectant mothers under NHIT have 10 free prenatal care visits [21]. Therefore, even if a transnational family is poor, the health of the mother and newborn during pregnancy and delivery is taken care of under the NHIT. In cases where fetal health problems are incurred during the pregnancy, parents can choose either to have an artificial abortion or to receive tocolysis to solve the minor health problem and to maintain the pregnancy. The prenatal care provided by NHIT can partially explain why the early neonatal mortality of foreign-born mothers' newborns was lower than that of mothers in their countries of origin.

From a non-economic point of view, how well foreign-born mothers adjust to the new environment in terms of acculturation and social support is an important factor linked to favorable birth outcomes [22, 23]. Although the data in the Taiwan Birth Registry lack information on measures of acculturation and social support, one study about Taiwan transnational marriage reported that foreign-born mothers tend to befriend mothers of the same community of origin after residing in Taiwan [24]. Hence, social support for foreign-born mothers should be as good as it is for Taiwan-born mothers.

Limitations of this study deserve discussion. First of all, underreporting of deaths or misclassifications of live births to stillbirths may jeopardize our finding. Babies who die very shortly after birth tend to be less likely to be registered than babies who die later in their life in underdeveloped countries [25]. However, the problem of underreporting deaths should be minimal as we used the Birth Registry, not the household registry. Secondly, the present data lack of information on maternal education, social economic status of the mother and father, and social support. Finally, the Taiwan Birth Registry does not contain information about survival days after birth and cause of deaths, post-neonatal care, and community or environmental factors. The effect of these factors on risk of death in the newborns are unable to be studied.

In conclusion, the Taiwan Birth Registry in 2004 showed that foreign-born mothers had a lower early neonatal mortality compared to Taiwan-born mothers after adjusting for important maternal and infant variables. Selection, economic and non-economic mechanisms may explain the paradox of favorable early neonatal outcomes in foreign-born mothers, but such speculations were not possible to examine using the Taiwan Birth Registry.

Acknowledgements This study was supported by the Public Health Bureau of Taoyuan County (PMRPD3010), National Science Council

(NZRPD140171) and the Ministry of Education, Taiwan, (EMRPD160051).

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