



## Original Article

## A nationwide population analysis of antenatal and perinatal complications among nurses and nonmedical working women

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## ABSTRACT

**Objective:** Limited information is available on health issues during pregnancy and after childbirth among nurses, especially on a nationwide level. This study thus aimed to compare antenatal and perinatal complications between nurses and nonmedical working women in Taiwan.

**Materials and Methods:** This nationwide population-based study was conducted using data from the Taiwan National Health Insurance Research Database. A total of 44,166 nurses and 442,107 nonmedical working women with full-time employment, aged 20–50 years, who gave birth to singletons were identified between 2007 and 2011. Logistic regression analyses (generalized estimating equation method) were used to compare risks between the two groups.

**Results:** Multivariable analyses showed that nurses had a significantly higher risk of anemia [adjusted odds ratio (AOR) 1.37; 95% confidence intervals (CI), 1.31–1.44], placenta previa, and abruptio placentae (AOR, 1.13; 95% CI, 1.07–1.20), and pregnancy-associated hypertensive diseases and preeclampsia (AOR, 1.10; 95% CI, 1.03–1.18) during the antenatal period than nonmedical working women. Moreover, they also experienced an increased risk of malpresentation (AOR, 1.30; 95% CI, 1.26–1.34), dystocia (AOR, 1.09; 95% CI, 1.06–1.13), preterm delivery (AOR, 1.08; 95% CI, 1.03–1.13), premature rupture of membranes (AOR, 1.09; 95% CI, 1.05–1.14), and post-term delivery (AOR, 1.11; 95% CI, 1.07–1.16) during the perinatal period.

**Conclusion:** Our nationwide population-based study revealed increased risks of antenatal and perinatal complications among nurses compared with those among nonmedical working women. The large-scale observation of the increased antenatal and perinatal complications draws attention to the health issues faced by nursing personnel who represent one of the most important workforces in the healthcare system.

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## Introduction

Nurses are believed to be more frequently exposed to biological/infectious, chemical, physical, and mechanical/ergonomic hazards and to more stressful, complex, and challenging circumstances than nonmedical working women [1,2]. Exposure to these factors during

pregnancy has been associated with an increased risk of antenatal and perinatal complications, such as pregnancy-induced hypertension, preeclampsia [3,4], reduced intrauterine growth, preterm delivery, and post-term delivery [5–7]. In addition, physically demanding work and irregular or night shifts have also been related to spontaneous abortion and preterm delivery among nurses [2,8,9]. Studies suggested that the antenatal health issues may be associated with occupational and psychological factors among nursing staff.

Nurses comprise the largest workforce in the healthcare sector worldwide [10], and approximately 75% of female nurses are of childbearing age [11]. Prior research has reported that nurses have a

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higher risk of pregnancy-related ambulatory care visits [12]. Only a few mail survey studies have focused on antenatal and perinatal complications of pregnant nurses [5,6,8,9]. Yang and coworkers [13] described a higher risk for cesarean deliveries, tocolysis, miscarriage, and preterm labor among nurses in a sampled population, instead of the whole population. Therefore, the present study used a nationwide population-based dataset to provide a more comprehensive analysis of the antenatal and perinatal complications among pregnant nurses in Taiwan.

## Materials and methods

### Data sources

This retrospective cross-sectional study was conducted using the Taiwan National Health Insurance Research Database (NHIRD) between 2007 and 2011, including the inpatient expenditures by admissions, registry for contracted medical facilities, registry for medical personnel, and registry for beneficiaries. The linkage of all datasets for the relevant variables used the scrambled unique personal or hospital identification numbers. Data confidentiality assurance and privacy protections were encrypted by the National Health Insurance Administration (NHIA) before the release of the data. Diagnostic and procedure codes for each inpatient were categorized based on the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) and the diagnosis-related group (DRG) coding. The NHIA performed expert reviews of random samples for inpatient claims quarterly to ensure the quality of care and accuracy of claim files. Additionally, the Institutional Review Board of the Chang Gung Memorial Hospital, Taoyuan, Taiwan approved our study (approval number: 102-4248B).

### Study population

We included a total of 489,245 nurses and nonmedical working women who gave birth to singletons from 2007 through 2011 by using DRG codes, including 0373A (normal spontaneous vaginal delivery), 0373C (vaginal delivery after cesarean delivery), 0371A (medically indicated cesarean delivery), and 0373B (elective cesarean delivery) on the basis of the NHIA's case-based payment system. We excluded 2859 (0.6%) women younger than 20 years or older than 50 years. Additionally, 113 (0.02%) women were excluded due to incomplete information regarding physicians attending the births. Our final sample comprised 44,166 nurses and 442,107 nonmedical working women who delivered singletons.

### Measures

The main outcome measure was the occurrence of the antenatal and perinatal conditions and delivery mode between nurses and nonmedical working women. We chose comprehensive items to cover antenatal and perinatal complications, according to our previous study [14] and Tang et al's [15] report, and information available in the NHIRD. Antenatal complications for pregnant women were defined as the presence of one or more of the following: placenta previa and abruptio placentae (ICD-9-CM code 641, 762.0, or 762.1), pregnancy-associated hypertensive diseases and preeclampsia (642.0, 642.1–642.5, 642.7, 642.9, or 760.0), anemia (648.2), gestational diabetes mellitus (648.0, 648.8, or 775.0), and intrauterine growth restriction (656.5). Perinatal complications for pregnant women were defined as the presence of one or more of the following: malpresentation (ICD-9-CM codes 652, 761.7, 763.0, and 763.1), dystocia (653 and 660–662, excluding 661.3), fetal distress (656.3), preterm delivery (< 37 weeks of gestation; 644), premature rupture of the membrane (PROM; 658.1

or 658.2), post-term delivery ( $\geq 42$  weeks of gestation; 645), and postpartum hemorrhage (666). Additionally, delivery modes were categorized as vaginal (DRG 0373A or 0373C) versus medically indicated cesarean delivery (0371A) or elective cesarean delivery (0373B) according to the NHIA's DRG codes.

Information on the occupation of the pregnant women was obtained from the registry for medical personnel and the registry for beneficiary files. Nurses were identified as the study group, while other nonmedical working women were identified as the comparison group. Only women who were employed full time were included, and they were classified into two categories: nurses [registered nurse specialists and registered nurses; midwives were not included because very few cases (<0.001%) were not suitable for analysis] and nonmedical working women who were employed full time and worked for government agencies or private institutions. The latter group was chosen as the comparison group on the basis of a presumed relatively low exposure to occupational hazards.

Covariates were selected based on prior research and information available in the NHIRD, which were as follows: characteristics of singleton mothers (including age, insurable income, beneficiaries' geographic location, previous cesarean delivery, diabetes mellitus, and genitourinary comorbidities), hospitals (accreditation and patient volume), physician gender, and calendar year of delivery.

We obtained information on personal insurable wages from the NHIRD registry for beneficiaries. Mothers' socioeconomic status was defined as a woman's own insurable wage if she was the insured, or the insurable income of the insured if she was a dependent, and was divided into three categories: low [ $\leq$  New Taiwan Dollars (NTD) 20,000], medium (NTD 20,001–39,999), and high ( $\geq$  NTD 40,000). We also grouped the region of each women's NHIA unit, by enrolling the beneficiaries' geographic location into four regions (northern, central, southern, and eastern) according to the National Statistics of Regional Standard Classification. Additionally, previous cesarean delivery (ICD-9-CM codes 654.2), diabetes mellitus (250), cardiovascular diseases (404, 414, 425.4, 429.2, 440.9, 648.5, 648.6, 710 794.3, and V17.4) [14], endometriosis (615 or 616), and infection of genitourinary tract in pregnancy (646.6) [16,17] were selected as covariates.

Information on institutional characteristics was retrieved from the registry for contracted medical facilities and medical personnel. Medical centers were the hospitals with the best overall evaluation results under Taiwan's hospital accreditation system, followed by regional hospitals and district hospitals. Patient volume was determined based on the average annual number of singleton mothers admitted to each hospital, and was classified into high ( $\geq 500$  cases per year) and low (< 500 cases per year) categories.

### Statistical analysis

Distributions of demographic characteristics, institutional factors, and antenatal and perinatal complications between pregnant nurses and nonmedical working women were examined using the Chi-square test or Fisher's exact test for categorical variables, and the Student *t* test for continuous variables when appropriate. Univariable and multivariable logistic regression analyses were used to estimate the difference in each antenatal and perinatal condition between the two groups. In addition, the generalized estimating equation (GEE) method with an exchangeable correlation structure was used to adjust for the possible clustering effect among women with multiple births. Odds ratios and 95% confidence intervals (CIs) were estimated. A *p* value < 0.05 was considered statistically significant. All analyses were performed using SAS version 9.2 (SAS Institute, Cary, NC, USA).

## Results

We identified 486,273 singleton deliveries in Taiwan during the study period, of which 44,166 were nurses and 442,107 were from nonmedical working women. A description of maternal demographics and institution and provider characteristics for nurses and nonmedical working women is presented in Table 1. In general, the nurses were at younger and had higher insurable wages (> NTD 40,000) than nonmedical working women ( $p < 0.001$ ). Nurses (13.6%) had a higher rate of previous cesarean delivery than nonmedical working women (11.6%,  $p < 0.001$ ). Additionally, the crude rates of genitourinary tract infection and endometriosis during pregnancy were marginally higher among pregnant nurses. In terms of institution and physician characteristics, nurses were more likely than nonmedical working women to be admitted to medical centers and regional hospitals or hospitals with a high patient volume. Pregnant nurses, compared with nonmedical working women, were slightly more likely to choose female physicians.

The occurrence of antenatal and perinatal complications and delivery mode between nurses and nonmedical working women is shown in Table 2. Nurses experienced a higher percentage of anemia, placenta previa and abruptio placentae, pregnancy-associated hypertensive diseases and preeclampsia, and intrauterine growth restriction during the antenatal period than nonmedical working

women. Nurses had a greater proportion of malpresentation, dystocia, preterm delivery, PROM, and post-term delivery during the perinatal period, but not of postpartum hemorrhage. Additionally, the crude rate of undergoing cesarean delivery was higher for nursing staff (35.7%) than for nonmedical working women (32.9%,  $p < 0.001$ ).

After controlling for patient characteristics and institutional factors, multivariable GEE analyses indicated that nurses were at a significantly higher risk of anemia [adjusted odds ratio (AOR), 1.37; 95% CI, 1.31–1.44], placenta previa and abruptio placentae (AOR, 1.13; 95% CI, 1.07–1.20), and pregnancy-associated hypertensive diseases and preeclampsia (AOR, 1.10; 95% CI, 1.03–1.18) during the antenatal period than nonmedical working women, whereas they had a lower risk of gestational diabetes mellitus (AOR, 0.8; 95% CI, 0.72–0.89). Moreover, nurses had a significantly increased risk of malpresentation (AOR, 1.30; 95% CI, 1.26–1.34), dystocia (AOR, 1.09; 95% CI, 1.06–1.13), preterm delivery (AOR, 1.08; 95% CI, 1.03–1.13), PROM (AOR, 1.09; 95% CI, 1.05–1.14), and post-term delivery (AOR, 1.11; 95% CI, 1.07–1.16) during the perinatal period after adjustment, whereas they were less likely to have fetal distress (AOR, 0.9; 95% CI, 0.83–0.96). Nurses (AOR, 1.16; 95% CI, 1.14–1.19) had a significantly higher probability of undergoing cesarean delivery than nonmedical working women, particularly medically indicated cesarean delivery. However, the difference in elective cesarean delivery was nonsignificant between the two groups (Table 3).

**Table 1**

Characteristics of maternal demographics, and institution and provider characteristics between nurses and nonmedical working women.

Characteristic	Nurses ( <i>n</i> = 44,166)		Nonmedical working women ( <i>n</i> = 442,107)		<i>p</i>
	<i>n</i>	%	<i>n</i>	%	
Year of delivery					<0.001
2007	8727	19.8	92,404	20.9	
2008	8813	19.9	89,597	20.3	
2009	9133	20.7	90,013	20.3	
2010	7712	17.5	76,074	17.2	
2011	9781	22.1	94,019	21.3	
Maternal age (y)					<0.001
20–29	17,667	40.0	164,561	37.2	
30–34	20,325	46.0	195,076	44.1	
≥35	6174	14.0	82,470	18.7	
Insurable income					<0.001
High (≥NTD 40,000)	15,808	35.8	136,305	30.8	
Medium (NTD 20,001–39,999)	19,195	43.5	196,270	44.4	
Low (≤NTD 20,000)	9163	20.7	109,532	24.8	
Geographic region					<0.001
Northern	19,417	44.0	239,323	54.1	
Central	8477	19.2	92,209	20.9	
Southern	15,249	34.5	104,367	23.6	
Eastern	1023	2.3	6208	1.4	
Previous cesarean delivery	6009	13.6	51,299	11.6	<0.001
Cardiovascular diseases	171	0.4	844	0.2	<0.001
Diabetes mellitus	62	0.1	471	0.1	0.049
Genitourinary comorbidity					
Genitourinary tract infection in pregnancy	282	0.6	1981	0.4	<0.001
Endometriosis during pregnancy	77	0.2	338	0.1	<0.001
Institutional accreditation					<0.001
Medical center	13,711	31.1	86,698	19.6	
Regional hospital	15,036	34.0	117,919	26.7	
District hospital	8799	19.9	111,852	25.3	
Obstetrics/gynecology clinic	6620	15.0	125,638	28.4	
Patient volume (cases per year)					<0.001
High (≥500)	26,034	59.0	245,407	55.5	
Low (<500)	18,132	41.0	196,700	44.5	
Physician gender					0.039
Female	4862	11.0	47,258	10.7	
Male	39,304	89.0	394,849	89.3	

NTD = New Taiwanese dollars.

**Table 2**  
Antenatal and perinatal conditions and delivery mode between nurses and nonmedical working women.

	Nurses (n = 44,166)		Nonmedical working women (n = 442,107)		p
	n	%	n	%	
<b>Antenatal condition</b>					
Anemia	2173	4.9	14,815	3.4	<0.001
Placenta previa & abruptio placentae	1313	3.0	10,061	2.3	<0.001
Pregnancy-associated hypertensive diseases and preeclampsia	1032	2.3	8206	1.9	<0.001
Gestational diabetes mellitus	447	1.0	4754	1.1	0.225
IUGR	290	0.7	2134	0.5	<0.001
<b>Perinatal condition</b>					
Malpresentation	4987	11.3	38,841	8.8	<0.001
Dystocia	5305	12.0	49,791	11.3	<0.001
Fetal distress	875	2.0	9709	2.2	0.003
Preterm delivery	2435	5.5	19,402	4.4	<0.001
PROM	2530	5.7	23,509	5.3	<0.001
Post-term delivery	3801	8.6	33,546	7.6	<0.001
Postpartum hemorrhage	340	0.8	3070	0.7	0.073
<b>Delivery mode</b>					
Vaginal delivery	28,410	64.3	296,849	67.1	<0.001
Cesarean delivery	15,756	35.7	145,258	32.9	
Medically indicated cesarean delivery	14,942	33.8	135,008	30.6	
Elective cesarean delivery	814	1.9	10,250	2.3	

IUGR = intrauterine growth retardation; PROM = premature rupture of membrane.

**Table 3**  
Odds ratios of antenatal and perinatal conditions and delivery mode among singleton births between nurses and nonmedical working women.

	Univariable model			Multivariable model <sup>a</sup>		
	OR	95% CI	p	AOR	95% CI	p
<b>Antenatal condition</b>						
Anemia	1.50	1.43–1.57	<0.001	1.37	1.31–1.44	<0.001
Placenta previa and abruption placentae	1.31	1.24–1.39	<0.001	1.13	1.07–1.20	<0.001
Pregnancy-associated hypertensive diseases and preeclampsia	1.26	1.18–1.35	<0.001	1.10	1.03–1.18	0.005
Gestational diabetes mellitus	0.93	0.84–1.03	0.16	0.80	0.72–0.89	<0.001
IUGR	1.36	1.20–1.54	<0.001	1.01	0.89–1.14	0.933
<b>Perinatal condition</b>						
Malpresentation	1.32	1.28–1.36	<0.001	1.30	1.26–1.34	<0.001
Dystocia	1.07	1.04–1.11	<0.001	1.09	1.06–1.13	<0.001
Fetal distress	0.90	0.84–0.97	0.003	0.90	0.83–0.96	0.003
Preterm delivery	1.27	1.21–1.33	<0.001	1.08	1.03–1.13	0.006
PROM	1.08	1.04–1.13	<0.001	1.09	1.05–1.14	0.003
Post-term delivery	1.15	1.11–1.19	<0.001	1.11	1.07–1.16	<0.001
Postpartum hemorrhage	1.11	1.00–1.24	0.068	1.05	0.93–1.18	0.237
<b>Delivery mode</b>						
Vaginal delivery	1.00			1.00		
Cesarean delivery	1.13	1.11–1.16	<0.001	1.16	1.14–1.19	<0.001
Medically indicated cesarean delivery	1.16	1.13–1.19	<0.001	1.18	1.15–1.21	<0.001
Elective cesarean delivery	0.84	0.78–0.91	<0.001	0.96	0.89–1.04	0.319

AOR = adjusted odds ratio; CI = confidence interval; IUGR = intrauterine growth retardation; OR = odds ratio; PROM = premature rupture of membrane.

<sup>a</sup> Adjusted for year of delivery, maternal age, insurable income, geographic region, previous cesarean delivery, cardiovascular diseases, diabetes mellitus, genitourinary comorbidities, institutional accreditation, patient volume, and physician gender as compared with nonmedical working women with singleton births.

## Discussion

To our knowledge, this is the first study to use a nationwide population-based dataset to describe a higher risk of comprehensive antenatal and perinatal complications in nurses than in nonmedical working women. The antenatal and perinatal complications included anemia, placenta previa and abruptio placentae, pregnancy-associated hypertensive diseases and preeclampsia, malpresentation, dystocia, preterm delivery, PROM, and post-term delivery, even after adjusting for relevant covariates (i.e., patient and institutional characteristics), compared with nonmedical working women. Furthermore, nurses were also more likely to undergo cesarean delivery than nonmedical working women after adjustment. Our data are correlative; further studies are needed to elucidate the causal relationship of these observations.

There are several possible explanations for these observations. First, nurses' work environments have specific ergonomic and physical aspects (prolonged standing and shift work), which may influence circadian rhythms and other hormonal mechanisms. Prolonged standing and frequent lifting during early pregnancy, which may affect constriction/dilatation of blood vessels, have been associated with an increased risk of pregnancy-associated hypertensive diseases, preeclampsia, and placenta previa and abruption placentae [3,18,19]. Meanwhile, more physically demanding activities may cause maternal anemia during pregnancy [5]. Additionally, prior research has demonstrated that women with previous cesarean delivery had an increased risk of placenta previa and placental abruption [20]. Therefore, more physically demanding activities and a history of previous cesarean delivery may cause an increased risk of antenatal complications among nurses.

Second, physical or psychological stress may increase the possibility of perinatal complications among nurses. Katz [19] reported that work-related stress was associated with a higher risk of preterm delivery, PROM, and low birth weight. Additionally, genitourinary comorbidities were reported to be associated with the occurrence of fetal malpresentation, dystocia, and postpartum hemorrhage during delivery [21]. In accordance with previous studies [5,7,13], we found that nurses were at an increased risk of anemia, placenta previa and abruptio placentae, pregnancy-associated hypertensive diseases, malpresentation, dystocia, preterm delivery, PROM, and post-term delivery.

Third, our nationwide population-based study indicated a higher probability of undergoing cesarean delivery among nurses, which is consistent with Yang et al's [13] findings from a sampled population. We also observed a greater proportion of previous cesarean deliveries among nurses than among nonmedical working women. Furthermore, in our analysis, nurse were more likely than nonmedical working women to undergo medically indicated cesarean delivery after adjustment, whereas the probability of undergoing elective cesarean delivery did not differ between the two groups. We believe that nurses were not more likely to avoid pain or were less tolerant of pain during delivery. However, several pregnancy conditions, such as previous cesarean delivery, maternal anemia, placenta previa and placental abruption, malpresentation, dystocia, and induction failure, may influence the rate of cesarean delivery [22,23]. Thus, a higher rate of cesarean delivery among nurses may be due to their increased risk of perinatal complications.

Fourth, nurses were exposed to the aforementioned occupational and environmental factors, which may affect their medical and obstetric conditions during the antenatal and perinatal periods. Huang and coworkers [12] showed that nursing staff have a greater incidence of ambulatory care visits for pregnancy- and childbirth-related complications than nonmedical working women. Additionally, nurses are considered to have a greater likelihood of exposure to occupational health hazards than nonmedical working women [1,2], which may increase the risks of spontaneous abortion, reduced intrauterine growth, preterm delivery, and low birth weight [4–7,13]. Therefore, high exposure to environmental factors may account for the increased risks for adverse antenatal and perinatal outcomes among nurses.

Alternatively, nurses have lower risks of gestational diabetes mellitus. This is hypothetically due to their appropriate dietary habits, better self-care, and better preventive knowledge [24]. Another explanation was proposed by Lao and Ho [25] that a lower prevalence of gestational diabetes mellitus was associated with anemia. The causal relationship whether the reduced likelihood of gestational diabetes mellitus among nurses is due to their anemia remains inconclusive in our study.

This study contributes uniquely to the published literature by identifying the effect of antenatal and perinatal complications among nurses by using data from medical records rather than from self-report measures of clinical conditions during pregnancy and delivery. It highlights the difference of antenatal and perinatal complications, e.g., 3.0% versus 2.3% in placenta previa and abruptio placentae, 11.3% versus 8.8% in malpresentation, and so on. The association between occupational exposures and pregnancy outcomes is important, and adds to our knowledge of the relevant risk factors and potential mechanisms for antenatal and perinatal conditions. Additionally, although the increased risks of antenatal and perinatal complications among nurses, compared with those among nonmedical working women, were small, these are of clinical significance to both pregnant nurses and healthcare providers. The small difference of odds ratios may come from the low prevalence of antenatal and perinatal complications.

Nevertheless, our study used odds ratios to provide an estimate of the relationship between variables, therefore, an easy-to-read interpretation.

Several potential limitations of this study should be considered. First, nonmedical working women may differ from nurses with regard to unmeasured socioeconomic variables, such as maternal education level, working environments, etc., which may impact the observed results. Hence, we selected nonmedical personnel with relatively low physical occupational exposures as the comparison group. Second, data on physical, chemical, biological, and psychosocial exposures and other lifestyle variables were not available due to claim data, all of which could be associated with the risks of antenatal and perinatal complications. Therefore, a more sophisticated analysis was not applicable. Third, the use of inpatient expenditures by admissions for prenatal risks may underestimate the difference between nurses and nonmedical working women. Owing to data limitations, information on the frequency of prenatal checkups and parity was not available. Hence, the true differences between the two groups might be even larger than those observed in this study. Even though statistical significance may come from a large sample size, as a large sample size is a better representative of the population, it limited the influence of outliers or extreme observations.

In conclusion, our nationwide population-based report observed increased risks of antenatal and perinatal complications among nurses compared with those among nonmedical working women. These findings for nurses may be related to the exposure to a myriad of work-related hazards, and physical and mental stresses. The large-scale observation of the increased antenatal and perinatal complication highlights health issues faced by nursing personnel, representing one of the most important workforces in the healthcare system.

### Conflicts of interest

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

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