Registered nurses are at increased risk of hospitalization for infectious diseases and perinatal complications: A population-based observational study

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A R T I C L E   I N F O

A B S T R A C T

Background: Nursing staff spend long periods in high-risk working environments.
Objective: The purpose of this study was to compare the hospitalization risk between nursing staff and the general population.
Design: This study adopted a retrospective observational design.
Setting: Data from the Taiwan National Health Insurance Research Database from 2011 to 2013 were analyzed.
Method: The standardized hospitalization ratio model was used to analyze the relative risk of hospitalization for various diseases between nursing staff and the general population.
Results: A total of 33,267 numbers of nursing staff in Taiwan were hospitalized, an overall crude hospitalization rate of 21.5%. After controlling for gender, calendar year, and age of nursing staff, the standardized hospitalization ratio of female nursing staff was significantly higher compared to the general population for infectious and parasitic diseases ($SHR = 121.05$, $95\%\ CI = 112.66–129.89$), diseases of the respiratory system ($SHR = 105.12$, $95\%\ CI = 100.60–109.80$), complications of pregnancy, childbirth, and the puerperium ($SHR = 102.59$, $95\%\ CI = 100.85–104.35$), and diseases of the skin and subcutaneous tissue ($SHR = 109.71$, $95\%\ CI = 101.10–118.86$).
Conclusions: Nursing staff have a significantly higher hospitalization risk compared to the general population for infectious and parasitic diseases, diseases of the respiratory system, complications of pregnancy, childbirth, and puerperium, and diseases of the skin and subcutaneous tissue. This may be associated with the job characteristics and environment of nursing staff.

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What is already known about the topic?

- Many studies have been conducted on the health of nursing staff, investigating aspects such as the role of shift work on cardiovascular health and metabolic syndrome
- Most of the previous studies on the health of nursing staff used questionnaire surveys and focused on a single health issue. For example, health of nursing staff, the effects of occupational fatigue, and occupational injury such as musculoskeletal discomfort and needle-stick infections.

What this paper adds

- The Taiwan National Health Insurance Research Database covers more than 99% of the Taiwanese population; as it is based on actual consultation records, it avoids recall/information bias common in sampling, interviews, and surveys.
- Nurses had significantly higher hospitalization risk compared to the general population for four categories of illness: infectious diseases, respiratory diseases, complications of pregnancy, and diseases of skin and subcutaneous tissue.

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1. Introduction

Nursing staff are the main work force in health care institutions (Ministry of Health and Welfare, 2016a,b). They provide direct first-line care to patients, and are the health care professionals who spend the longest contact time with patients. Previous studies have pointed out that nursing work involves long working hours, highly stressful working environments (Chou et al., 2014), potential hazardous substances in the workplace (bacteria, viruses, and radiation), and shift work. This implies that nursing staff work for long periods in high-risk working environments (Gershon et al., 2007; Wang and Li, 2015), and are concerned about having a positive work environment, which may explain the nursing practice rate of only 59% in Taiwan (Taiwan Union of Nurses Association, 2017); this rate is significantly lower than the 84% in the US in 2012 (Juraschek et al., 2012) and 91% in Canada in 2016 (College of Nurses of Ontario, 2016). In 1995, Taiwan began implementing National Health Insurance, and the insured population coverage reached 99.6% in 2017 (National Health Insurance Administration, 2017). According to 2015 statistics, there were over 22 million hospitalizations (including emergency departments) and the visiting rate was 94,219 visits per 100,000 population (Ministry of Health and Welfare, 2016a,b); thus, the right to equal medical treatment was achieved. However, after the overall hospital budget system was established, each hospital started to adopt various flexible labor measures to control costs and reduce nursing staff, which increased nursing workloads (Kao, 2011; Liang et al., 2010) and led to a deteriorating working environment, such as higher nurse-patient ratios of 1:7-16 (Taiwan Union of Nurses Association, 2016). It is a significant concern whether nursing staff are at high risk from disease due to occupational specificity and working environment.

Many studies have been conducted on the health of nursing staff, investigating aspects such as the role of shift work in cardiovascular health (Colquhoun et al., 2013; Vetter et al., 2016); metabolic syndrome (Canuto et al., 2013; Chang and Liao, 2015); the effects of occupational fatigue (Zhou and Fang, 2015); occupational injury such as musculoskeletal discomfort (Davis and Kotowski, 2015); and needle-stick infections (Chiu et al., 2011). Most of the above studies used questionnaire surveys and focused on a single health issue. Their advantage is that they enable an in-depth understanding of the issue; however, the sample size was often too small and participants were limited to one region. On the other hand, the Taiwan National Health Insurance Research Database (NHIRD) has a coverage of more than 99%, which includes the health information of almost all citizens; therefore, the possibility of selection bias is greatly reduced. Moreover, the Taiwan NHIRD is an actual visiting record, which does not involve subjective data obtained from individuals' memories and answers. Therefore, the use of this database can avoid recall/information bias, which is common in sampling, interviews, and surveys. Thus, this study used the Taiwan NHIRD to investigate and compare hospitalization risk between nursing staff and the general population.

2. Literature review

As patients must undergo 24 h of continuous care when they are hospitalized, clinical nursing staff must rotate in three shifts. Shift work is a common source of stress and may have a significant physiological and psychological impact, which can lead to cerebrovascular and cardiovascular diseases (Colquhoun et al., 2013) and increase the risk of stroke (Brown et al., 2009). Vetter et al. (2016) carried out a prospective cohort study on 189,158 healthy female nursing staff in a 24-year follow up, and found that the number of years of shift work was highly associated with an increased risk of coronary heart disease. Staff who have worked shifts for long periods are also prone to having health problems, i.e., overweight or obesity, metabolic syndrome, and diabetes (Canuto et al., 2013). Nursing staff are also a high-risk population for occupational stress and workplace fatigue (Lu et al., 2014). Their occupational stress originates from excessive workload, patients' aggressive behavior, shift work, low social support, stress due to further education, and financial status (Lim et al., 2010). The increase in patient-to-nurse ratio further exacerbates the situation. The Taiwan Union of Nurses Association (2016) pointed out that in 2015, the average nurse-patient ratios in health care institutions in Taiwan were 7–10 in the morning shift, 13–14 in the afternoon shift, and 13–16 in the night shift, which is higher than the 5.2 in Norway, 6.9 in Ireland, and 8.8 in the UK (Aiken et al., 2014).

Besides affecting physical and mental health, high stress and workplace fatigue can also affect nursing care quality. For instance, workplace fatigue may increase the rates of needle-stick injury and medication administration errors, endanger the lives of patients, increase absence rates from work, and decrease work satisfaction (Lu et al., 2014). Nursing staff are also required to stand for long periods, move patients or heavy objects, collect samples (e.g., blood collection), and input data into computers. These tasks involve repetitive waist, hand, and shoulder movements that may cause nursing staff to become a high-risk population for musculoskeletal injuries (Davis and Kotowski, 2015). To summarize the above literature, the work characteristics of nursing are a predominance of shift work, a heavy workload, and exposure to an environment with a high risk of occupational injury (e.g., needle-stick and musculoskeletal injury). They may affect nurses' sleep, digestion, metabolic and cardiovascular systems, mental health, and the likelihood of developing cancer.

Previously, Lin et al. (2008) used the hospitalization medical costs file in the NHIRD and the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) to analyze hospitalization risk according to seven categories from the top ten most common causes of death, hospitalization diseases, and exposure/ occupational injury of health care professionals at work in Taiwan. We used the methodology of Lin et al. (2008) to further explore the hospitalization risk of nursing staff. Generally, most studies examining healthcare utilization behavior have adopted the behavior model of health service utilization proposed by Aday and Andersen (1974). This model has eight dimensions: type of utilization, site of medical care, purpose, time interval for a visit, health policies, healthcare delivery system, consumer satisfaction, and characteristics of population at risk. Our study defined hospitalization risk measurement indicators as follows: (1) Purpose of hospitalization: the ICD-9-CM code was used for the classification of disease and injury diagnosis (Table 1); (2) Hospitalization rate: number of hospitalizations and length of hospitalization in days; (3) Site of hospitalization: whether the site of hospitalization was a medical center or a regional, district, or primary hospital.

3. Methods

This was an observational study using a retrospective descriptive design. Data were obtained from the Taiwan NHIRD, created by the National Health Research Institute (NHRI) after encryption of personal data from the National Health Insurance Administration. After approval was granted by the NHRI and the Institutional Review Board of Kaohsiung Medical University Hospital (KMUHIRB-EXEMPT (1)-20150055), NHIRD data from 2011 to 2013 were analyzed. The files used included the registry of medical personnel and inpatient expenditures by admissions. These files are connected using unique personal identification numbers.

Table 1
Nurses' Diagnosis of Disorders (Hospitalization Risk Indicators) Used in This Study.

Original diagnosis of disorder (ICD-9-CM[*])	Diagnosis of disorder used in this study (ICD-9-CM)
1.Infectious and parasitic diseases (001-139)	Infectious and parasitic diseases (001-139)
2. Neoplasms (140-239)	**Malignant neoplasms** (140-208)
	Benign neoplasms (210-239)
3. Endocrine, nutritional and metabolic diseases, and immunity disorders (240-279)	Endocrine, nutritional and metabolic diseases, and immunity disorders (240-279)
4. Diseases of the blood and blood-forming organs (280-289)	Diseases of the blood and blood-forming organs (280-289)
5. Mental, behavioral and neurodevelopmental disorders (290-319)	Mental, behavioral and neurodevelopmental disorders (290-319)
6. Diseases of the nervous system (320-389)	Diseases of the nervous system (320-389)
7. Diseases of the circulatory system (390-459)	Diseases of the circulatory system (390-459)
8. Diseases of the respiratory system (460-519)	Diseases of the respiratory system (460-519)
9. Diseases of the digestive system (520-579)	Diseases of the digestive system (520-579)
10. Diseases of the genitourinary system (580-629)	Diseases of the genitourinary system (580-629)
11. Complications of pregnancy, childbirth, and the puerperium (630-679)	Complications of pregnancy, childbirth, and the puerperium (630-679)
12. Diseases of the skin and subcutaneous tissue (680-709)	Diseases of the skin and subcutaneous tissue (680-709)
13. Diseases of the musculoskeletal system and connective tissue (710-739)	Diseases of the musculoskeletal system and connective tissue (710-739)
14. Congenital anomalies (740-759)[a]	
15. Certain conditions originating in the perinatal period (760-779)[b]	
16. Symptoms, signs, and ill-defined conditions (780-799)	Symptoms, signs, and ill-defined conditions (780-799)
17. Injury and poisoning (800-999)	Injury and poisoning (800-999)
18. Supplementary classification of factors influencing health status & contact with health services (v01-v91)[c]	

[ab]Diagnosis of disorders regarding neonates.
[c]Supplementary explanation of factors influencing health status & needs of health services.
[*] Numbers in parenthesis are the International Classification of Diseases 9th Revision, Clinical Modification (ICD-9-CM) codes.

The exclusion criteria and reasons were as follows: (1) In Taiwan, nurses normally obtain their nursing practitioner/nurse license for practice after graduation from 5-year college programs (age around 19 years), and the retirement age is 65. Therefore, data from individuals aged below 19 or aged 65 and above were excluded; (2) Records where the personal identification number or gender was blank were excluded; (3) Normal delivery records were excluded. The diagnosis code for normal delivery in ICD9-CM is 650; (4) The following diagnostic codes for neonatal disease were excluded: neonatal dependent treatment code for partial cost exemption (903), code for congenital abnormalities (740–759), and diseases of the perinatal period (760–779).

The data "Registry for health care personnel" used in this study is a registry-based dataset; all health care professionals with a government license are included in this dataset. Any changes regarding the practice status/unit of health care professionals should be reported via the individual or institute to the health governing authority according to law. We can therefore check the practice status using the "WORK_ STATUS Practice Status" variable in the "Registry for health care personnel" dataset. We deleted three diagnoses of disorders in the ICD-9-CM codes (Numbers 14 and 15 (diagnosis of disorders regarding neonates) and Number 18 (supplementary explanation of factors influencing health status and needs of health services) because they are not factors related to nurses' hospitalization risk. For the hospitalization risk, we divided the code for neoplasms (Number 2) into two subtypes (malignant and benign neoplasms). Finally, the main diagnoses in the ICD-9-CM were used to classify 16 types of diseases/systems/injury (Table 1) in order to compare the categories of disease and injury for hospitalization risk between nursing staff and the general population.

SPSS 20.0 was used for statistical analysis. Frequency distributions, percentages, and means (standard deviations) were used for descriptive statistics analysis. The number of practicing nursing staff in Taiwan during the study period was also calculated. Microsoft Office Excel 2010 was used to calculate the standardized hospitalization ratio (*SHR*) and its 95% confidence interval (*CI*), according to the method of previous related studies (Bright et al., 2017; Lin et al., 2008; Tuchsen, 1993).

4. Results

There were 2366 male and 152,143 female nurses included in this study, representing 1.5 and 98.5%, respectively, of the study cohort (Table 2). The mean age of the study cohort was 33.7 years with a standard deviation of 8.9 years, and the 19–29 age group had the highest number of nursing staff (n = 60,537; 39.2%), followed by the 30–39 age group (n = 60,002; 38.8%). About 24.2% of nurses (n = 37,464) worked at medical centers and 29.9% (n = 46,273) at regional hospitals.

Our study analyzed hospitalization data from 2011 to 2013 and the results are shown in Table 3. It was found that 33,267 numbers of nursing staff were hospitalized in this period. Most were female (n = 33,027; 99.3%), the average hospitalization age was 34.57 (7.70) years, and the 30–39 age group had the highest number of hospitalized nursing staff (n = 18,378; 55.2%). In terms of choice of site of hospitalization, most nursing staff were hospitalized at regional hospitals (n = 14,288; 42.9%), followed by medical centers (n = 12,826; 38.6%).

Table 2
Demographic Characteristics of the Studied Nurses Cohort in Taiwan.

	N	%
Gender		
Male	2366	1.5
Female	152,143	98.5
Age (Mean ± SD)	33.7	±8.9
19-29	60,537	39.2
30-39	60,002	38.8
40-49	24,625	15.9
50-59	8,295	5.4
60-65	1,050	0.7
Workplace		
Medical center	37,464	24.2
Regional hospital	46,273	29.9
Local hospital	21,457	13.9
Clinics	23,689	15.3
Others	25,626	16.6
Total	154,509	100

Table 3
Basic Information Analysis of Hospitalization Nursing Staff in Taiwan.

Characteristic	Number of Hospitalization		Crude Hospitalization Rate★
	Events	%	
Gender			
Male	240	0.7	10.1
Female	33,027	99.3	21.7
Age (years)			
19-29	7,926	23.8	13.1
30-39	18,378	55.2	30.6
40-49	4,907	14.8	19.9
50-59	1,768	5.3	21.3
60-65	288	0.9	27.4
Workplace			
Medical center	7,242	21.8	
Regional hospital	11,697	35.2	
Local hospital	5,617	16.9	
Clinics	4,028	12.1	
Others	4,683	14.1	
Type of affiliation			
Medical center	12,826	38.6	–
Regional hospital	14,288	42.9	–
Local hospital	4,892	14.7	–
Clinics	1,071	3.2	–
Others*	190	0.6	–
Total	33,267	100	21.5

★ Crude Hospitalization Rate= (Number of Hospitalization/Nurses staff)*100%.

From the 2011–2013 nursing staff hospitalization data, the length of hospitalization for nursing staff was 5.73 ($\pm$15.63) days, and the mean number of hospitalizations was 1.35 per staff member. Regarding female nursing staff, 33,027 were hospitalized, accounting for 99.3% of all hospitalized nursing staff, the length of hospitalization was 5.74 ($\pm$15.69) days, and the mean number of hospitalizations was 1.35 per staff member. As for male nursing staff, 240 were hospitalized, accounting for 0.7%, the length of hospitalization was 3.85 ($\pm$3.02) days, and the mean number of hospitalizations was 1.23 per staff member. The crude hospitalization rate for nursing staff was 21.5%. The crude hospitalization rates for male and female nursing staff were 10.1% and 21.7%, respectively, and the highest rate of crude hospitalization was for the group aged 30–39 years old (30.6%), followed by those aged 60–65 years old (27.4%) (Table 3).

The sample size and distribution of hospitalization age were significantly different between nursing staff and the general population, controlling for gender, calendar year, and age of the two populations. After adjusting for the differences between the groups, a standardized analysis of hospitalizations was performed. The results showed that the hospitalization risk for female nursing staff was significantly higher than that for the general population for infectious and parasitic diseases (SHR = 121.05, 95% CI = 112.66–129.89), diseases of the respiratory system (SHR = 105.12, 95% CI = 100.60–109.80), complications of pregnancy, childbirth, and puerperium (SHR = 102.59, 95% CI = 100.85–104.35), and diseases of the skin and subcutaneous tissue (SHR = 109.71, 95% CI = 101.10–118.86). The difference in hospitalization risk for the category "symptoms, signs, and ill-defined conditions" did not reach statistical significance. Moreover, the hospitalization risk for female nursing staff in relation to the remaining 11 systemic disease diagnostic categories was lower than that of the general public (Table 4).

On the other hand, after controlling for gender, calendar year, and age, the hospitalization risk for injury and poisoning of the male nursing staff was significantly lower than that of the general population (SHR = 72.48, 95% CI = 52.23–97.98), while there were no significant differences in hospitalization risk for the remaining diagnosis of disorders from ICD-9-CM (Table 4).

5. Discussion

After controlling for gender, calendar year, and age, our study found that in terms of infectious and parasitic diseases, the risk of hospitalization in nursing staff was significantly higher than in the general population. These infectious diseases included tuberculosis, zoonotic bacterial diseases, and viral infections. Chu et al. (2014) found that health care professionals had a higher risk in particular of contracting pulmonary tuberculosis (PTB), which was more than twice as high among nursing staff (aHR = 2.55; 95% CI, 1.37–4.72) compared to the general population. Kim et al. (2016) carried out a prospective study with 872 health care workers (including nurses (70.8%), nursing aides, technical assistants, cleaning staff, and physical therapists) who had contact with 55 patients with PTB and found that the prevalence of latent PTB in exposed health care workers was 6.6% and its incidence was 2.4%. This demonstrates that health care workers have a higher risk of contracting PTB than do the general public, as they directly care for infected patients.

In terms of respiratory diseases, the risk of hospitalization in nursing staff was significantly higher than in the general population, which is consistent with the results of a study by Lin (2005). In 2003, an outbreak of Severe Acute Respiratory Syndrome (SARS) resulted in 8098 individuals infected globally, of which health care professionals accounted for 21% (World Health Organization, 2003). In May 2015, South Korea experienced a Middle East Respiratory Syndrome (MERS) outbreak, and a total of 186 people were confirmed to be infected by July 2015, of which 31 (17%) were health care professionals (Ki, 2015). Therefore, a possible reason for the higher incidence of respiratory diseases in nursing staff compared with the general public is that once patients with respiratory diseases are hospitalized, clinical nursing staff are the first-line health care professionals caring for them. As nursing staff are exposed to a sealed and infection-prone environment, their probability of being infected is many times higher than that of the general population.

In terms of complications of pregnancy, childbirth, and puerperium, the risk of hospitalization in nursing staff was significantly higher than that in the general population. Previous studies have reported a prevalence of premature births or miscarriages lower than 10% in women in the general population (Arck et al., 2008), while this was 20% in nursing staff (Luke et al., 1995; Yang and Yin, 2004). The risk of natural miscarriage was found to double in nursing staff who had contact with anti-cancer drugs, particularly in the first trimester of pregnancy (Lawson et al., 2012). Chen and Chuang (2011) pointed out that nursing shift work and stress were associated with dysmenorrhea, irregular menstrual periods, delayed pregnancy, premature birth, and miscarriage in female nursing staff.

In terms of malignant and benign tumors, the risk of hospitalization in nursing staff was significantly lower than in the general population. This was inconsistent with the results of a study by Shen et al. (2013), which used the general information file of Taiwanese health care professionals in the NHIRD and the Longitudinal Health Insurance Database 2000 to analyze the number of nursing staff who contracted cancer in 2000–2010. Of the 184,809 practicing female nursing staff identified in that study, 2077 developed cancer; the incidence of cancer in the 40–59 age group was significantly higher (SIR = 1.14, 95% CI = 1.08–1.21) and the overall incidence of cancer in nursing staff was higher than in the general population. The types of cancer with a significantly higher risk for nursing staff than for the general population included breast cancer (SIR = 1.28, 95% CI = 1.19–1.37), thyroid cancer (SIR = 1.26, 95% CI = 1.10–1.43), lung cancer and mediastinal tumors (SIR = 1.36, 95% CI = 1.13–1.62), and uterine cancer (SIR = 1.23, 95% CI = 1.01–1.49). A possible reason for the inconsistency between our study results and those of Shen et al. (2013) could be

Table 4
Disease-Specific Standardized Hospitalization Ratios (SHRs) Among Nurses in Taiwan as Reference to the General Population.

Diagnosis of Disorder[*]	Number of hospitalization		SHR (%)[#]			
	Observed	Expected	Estimated	95%CI		
Infectious and parasitic diseases						
Male	15	9	160.5	89.8	–	264.8
Female	773	638	121.1★	112.7	–	129.9
Malignant neoplasms						
Male	6	9	62.1	22.7	–	135.2
Female	1,295	1,821	71.1★	67.3	–	75.1
Benign neoplasms						
Male	4	3	106.1	28.6	–	271.7
Female	1,677	1,931	86.8★	82.7	–	91.1
Endocrine, nutritional and metabolic diseases and immunity disorders						
Male	6	5	116.4	42.5	–	253.3
Female	442	669	66.03★	60.0	–	72.5
Diseases of the blood and blood-forming organs						
Male	1	1	101.3	1.3	–	563.7
Female	135	161	83.4★	69.9	–	98.8
Mental, behavioral and neurodevelopmental disorders						
Male	–	–	–	–	–	–
Female	199	2,991	6.65★	5.8	–	7.6
Diseases of the nervous system						
Male	3	7	43.3	8.7	–	126.6
Female	651	727	89.5★	82.8	–	96.7
Diseases of the circulatory system						
Male	19	15	125.5	75.5	–	196.1
Female	789	1,166	67.7★	63.0	–	72.5
Diseases of the respiratory system						
Male	31	30	104.6	71.0	–	148.5
Female	2,027	1,928	105.1★	100.6	–	109.8
Diseases of the digestive system						
Male	34	39	86.1	59.6	–	120.4
Female	1,911	2,285	83.6★	79.9	–	87.4
Diseases of the genitourinary system						
Male	19	14	134.7	81.0	–	210.3
Female	2,866	3,435	83.4★	80.4	–	86.5
Complications of pregnancy, childbirth, and the puerperium						
Male	–	–	–	–	–	–
Female	13,269	12,933	102.6★	100.9	–	104.4
Diseases of the skin and subcutaneous tissue						
Male	15	10	153.3	85.7	–	252.9
Female	599	546	109.7★	101.1	–	118.9
Diseases of the musculoskeletal system and connective tissue						
Male	14	16	85.9	46.9	–	144.2
Female	1,099	1,313	83.7★	78.8	–	88.8
Symptoms, signs, and ill-defined conditions						
Male	4	6	66.6	17.9	–	170.6
Female	525	483	108.6	99.5	–	118.3
Injury and poisoning						
Male	42	58	72.5★	52.2	–	98.0
Female	1,865	2,669	69.9★	66.7	–	73.1

[*] Numbers in parenthesis are the International Classification of Diseases 9th Revision, Clinical Modification (ICD-9-CM) codes.
[#] Age, gender, and calendar year-standardized hospitalization ratio in percent.
★ $P < 0.05$.

that our study used the hospitalization medical costs file to assess hospitalization risk. In cancer patients, however, their treatment may not necessarily require hospitalization, as outpatient follow-up treatment can be provided, resulting in a disparity in the results.

In terms of hospitalization due to musculoskeletal diseases, the risk of hospitalization in nursing staff was significantly lower than in the general population. However, previous studies have pointed out that nurses are a high-risk population for musculoskeletal diseases because of their job characteristics. A possible reason for this inconsistency may be that the present study mainly focused on hospitalization risk, while studies have pointed out that musculoskeletal diseases in nursing staff are mainly neck, shoulder, and lower back pain, and wrist discomfort (Wang et al., 2015), which are usually treated in outpatient follow-up.

Our study found that the mean length of hospitalization for nursing staff was 5.73 (±15.63) days (3.85 days for males and 5.74 days for females). On the other hand, the length of hospitalization for the general population was 9.94 days (10.49 days for males and 9.49 days for females). This shows that the average length of hospitalization among nursing staff was lower than in the general population. Possible reasons for this are the fact that nursing staff possess professional nursing knowledge and will seek efficient treatments, as well as the potential effects of the "healthy worker effect" (in other words, when workers are hired, their physical health must be relatively good; thus, they have lower morbidity and mortality rates than the general public [Kirkeleit et al., 2013]), which increases hospitalization care efficiency and decreases the length of hospitalization. On the other hand, the average length of hospitalization in Taiwan (9.84 days) is higher than that in the US (5.50 days) (OECD, 2017).This impacts the intensity of care required and subsequent nursing caseload.

6. Limitations

The data used in this study were obtained from the NHIRD database between 2011 and 2013, and our results are representative. However, as this was an administrative database, the integrity of the data content could not be completely controlled. This is the main study limitation. In addition, (1) in terms of work experience, the career mobility of the nursing profession in Taiwan is high and nursing staff often change their workplace; therefore, we were unable to investigate the correlation between work experience and hospitalization risk; (2) Due to limitations in data variables, we were unable to carry out further examination of the association of occupational fatigue in nursing staff from different departments (such as intensive care units, operating theaters, anesthesiology departments, and wards) and shift work with hospitalization risk.

7. Conclusions and implications

A total of 33,267 numbers of nursing staff in Taiwan were hospitalized between 2011 and 2013. After controlling for gender, calendar year, and age, female nursing staff showed a significantly higher hospitalization risk compared to the general population for infectious and parasitic diseases, diseases of the respiratory system, complications of pregnancy, childbirth, and puerperium, and diseases of the skin and subcutaneous tissue. This may be associated with the job characteristics and environment of nursing staff; therefore, we propose the following recommendations: (1) Infectious diseases: Periodic X-ray examinations with good risk exposure monitoring for high-risk nursing staff (taking account of potential harm and benefit, e.g. risk for cancer), implementation of infection control in on-job training education, provision of comprehensive protective equipment, and correct wearing of surgical masks at appropriate times; (2) Respiratory system: Studies have pointed out that influenza vaccines could have a protective effect (Osterholm et al., 2012). In Taiwan, only 72.9% of practicing medical personnel undergo influenza vaccination (Centers for Disease Control, 2016). Therefore, it is necessary to increase the influenza vaccination rates of Taiwanese health care professionals. Currently, Taiwan's policies include vaccination rates as one of the medical accreditation indicators to encourage hospitals to advocate vaccinations for all their health care professionals. In addition, poor hospital indoor air quality (IAQ) may lead to hospital-acquired infections and various occupational hazards (Verde et al., 2015). Thus, we recommend that hospitals periodically monitor their air quality; (3) Delivery and puerperal complications: Currently, all Taiwanese hospitals have implemented the Labor Standards Act regarding the pregnancy period whereby pregnant staff are not to work from 10 p.m. to 6 a.m. of the next day. We further recommend that hospital policy should establish a labor replacement system for pregnant staff in order to provide assistance to staff in their departments and prevent pregnant staff from working in a high-risk working environment. Constructing a supportive working environment for friendly nursing practice is also significant. Channels and mechanisms should be established to care for pregnant staff in order to provide life and work assistance, and support at different stages of pregnancy to alleviate their stress and promote their health.

Conflict of interest

The authors report no conflict of interest.

Acknowledgments

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