ORIGINAL ARTICLE

# Incidence and risk factors of needle stick and sharp injuries among registered nurses in Thailand

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## Abstract

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Needle stick and sharp injuries (NSIs) and persistent needle stick and sharp injuries (PNSIs) are serious occupation hazards among registered nurses (RNs). This study aims to estimate the incidence rate of NSIs and PNSIs and identify risk factors of PNSIs. Data from the first wave of the Thai Nurse Cohort Study, where cohort members were enrolled in 2009 and the second wave, a 3-year follow-up survey in 2012 were analyzed. NSIs were defined as self-reported NSIs during the previous 12 months in either wave, while PNSIs were those who reported NSIs in both waves.

Among 13,754 RNs in wave 1, the incidence rate was 0.27 per person-years (95% CI= 0.26-0.28). Wave 2 included 8,238 RNs who remained in the study, where the incidence rate of NSIs was 0.17 per person-years (95%CI= 0.16-0.18). The NSIs had reduced by 48% after the 3-year follow-up (OR = 0.52; 95%CI= 0.47-0.57). The prevalence of PNSI was 17.4%, based on the total number of 240 RNs who reported persistent NSI. The strongest risk factor of PNSI was working on night shifts for > 16 shifts per month (Adj OR=3.20; 95%CI= 1.70-6.00) compared to not working night shifts.

In the context of blood borne infections, universal precaution and prevention of NSI is critical to safeguard health workforce. Nurses especially those who work in night shifts should be taught preventative strategies against NSIs and PNSIs. PNSI is an indicator reflecting failure of preventive measures.

**Keywords:** needle stick and sharp injuries, persistent needle stick and sharp injuries, registered nurses, cohort study, Thailand

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# อุบัติการณ์และปัจจัยเสี่ยงต่อการถูกเข็มทิ่มตำและของมีคมบาดในพยาบาลวิชาชีพประเทศไทย

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**บทคัดย่อ**

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การได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมบาด และการยังคงได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมบาด เป็นสิ่งคุกคามในพยาบาลวิชาชีพ การศึกษาในครั้งนี้เพื่อประมาณค่าอุบัติการณ์การได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมบาด และการยังคงได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมบาด และหาปัจจัยเสี่ยงต่อการยังคงได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมบาด ใช้ข้อมูลระยะที่ 1 จากโครงการศึกษาพยาบาลไทยในระยะยาว ปี ค.ศ 2009 ติดตามข้อมูลลังจากนั้น 3 ปี ใช้ข้อมูลระยะที่ 2 ปี ค.ศ 2012 การได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมบาด เป็นการรายงานด้วยตนเองว่าใน 12 เดือนที่ผ่านมาได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมบาดหรือไม่ในแต่ละระยะ ส่วนการยังคงได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมบาด คือพยาบาลที่ได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมบาดทั้ง 2 ระยะ

พยาบาลวิชาชีพจำนวน 13,754 คน ในระยะที่ 1 พบ อุบัติการณ์การได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมบาด 0.27 ต่อ คน-ปี (95% CI= 0.26-0.28). ระยะที่ 2 พยาบาลวิชาชีพจำนวน 8,238 พบ อุบัติการณ์ 0.17 ต่อ คน-ปี (95%CI= 0.16-0.18). การได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมบาดลดลง 48% หลังจากติดตาม 3 ปี (OR = 0.52; 95%CI= 0.47-0.57). มีความชุกของคนที่ยังคงได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมบาด 17.4% คิดเป็นจำนวนทั้งหมด 240 คน ปัจจัยเสี่ยงต่อการยังคงได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมคือการทำงานกะกลางคืนมากกว่า 16 ครั้งต่อเดือน (Adj OR=3.20; 95%CI= 1.70-6.00) เมื่อเทียบกับพยาบาลที่ไม่ได้ทำงานกะกลางคืน

การป้องกันการติดเชื้อแบบครอบจักรวาลเป็นสิ่งสำคัญต่อการป้องกันการติดเชื้อที่ปนเปื้อนกับเลือด พยาบาลที่ทำงานกะกลางคืนนั้นควรได้รับการอบรมการป้องกันตนเองจากการได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมบาด การยังคงได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมบาดถือเป็นตัวสะท้อนถึงความล้มเหลวของมาตรการการป้องกัน

**คำสำคัญ:** การได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมบาด การยังคงได้รับบาดเจ็บจากการถูกเข็มทิ่มตำและของมีคมบาด พยาบาลวิชาชีพ การศึกษาระยะยาว ประเทศไทย

## Introduction

Approximately 35 million health care workers (HCWs) worldwide are subject to percutaneous injuries by contaminated sharp objects from the clinical settings[1]. In particular, needle stick and sharp injuries (NSIs) are occupational hazards specifically related to blood-borne pathogen infections such as: hepatitis B virus, hepatitis C virus, and human immunodeficiency virus, which result in high morbidity, mortality and economic loss worldwide[1-3]. The HCW incidence report notes a high occurrence of NSIs of greater than 50% of total incidences[4]. Registered nurses (RNs) are the largest population among HCWs who work directly with patient care[4]. Their clinical and nursing service activities expose to greater risk of NSIs[5-8]. A study conducted in the United States of America reported that the rates of occupational exposure to patient's blood were the highest among nurses and midwives; nurses have 4.27 times more exposed than physicians[9].

A number of studies looking at the NSIs incidence have been reported elsewhere for example: Australia (0.2 events per nurse-year)[10]; the USA (0.8 events per nurse-year)[11]; Japan (0.75 events per nurse-year)[12]; Iran (1.2 events per nurse-year)[13]; Taiwan (1.6 per HCW-year)[14], and quite high among countries in Sub-Saharan Africa (4.18 events per nurse-year)[15].

Several factors associated with NSIs are reported such as: years of service; place of work; age; emotional exhaustion; work environment; fatigue; shift work; and hours worked per week[11-12, 16-22]. Health care workers who attended educational programs on injury prevention were not related to needle stick injuries. Following universal precautions were protective factor (OR= 0.34; 95%CI= 0.17-0.68)[17]. Although the Centers for Disease Control (CDC) developed specific guidelines to prevent NSIs[23], they still occur in many countries[24]. In Nepal, 44.7% of nursing students experienced more than one NSI during their study[25]. In Iran, 75.6% of nurses had one to four NSIs in the past year[26]; and in Japan, 42.6% of the nurses at a teaching hospital had experienced multiple needle stick related injuries in one year[12]. Non-studies investigated the magnitude of persistent needle stick and sharp injuries (PNSIs).

In Thailand, the studies evaluating the magnitude of NSIs and PNSIs among RNs are limited. Additionally, change of NSIs incidence over time reflects the success or failure of preventive interventions. This study is the first step toward developing a guideline based on the real country context and evidence, for effective NSI prevention in Thailand.

This study aims to determine the incidence rate of NSIs among registered nurses in Thailand using the Thai Nurse Cohort Study (TNCS) and a three-year follow-up which contribute to the incidence of PNSI. Consequently, identifying the key risk factors of PNSI contributes to effective preventative measures.

## Methods

*Study design*

This study utilized data from the TNCS database. TNCS is a 20-year longitudinal cohort study. In 2009 and 2012, TNCS conducted a baseline survey. A random sample of RNs who held nursing licenses granted by the Thailand Nursing and Midwifery Council (TNC) in 2008 were surveyed via mailed-questionnaires. Those who responded were enrolled into the study. TNCS aims to investigate the workforce dynamics and health conditions of Thai RNs.

*Sampling method*

A total of 142,699 RNs who held nursing licenses and whose names were listed in the TNC database in 2009 formed the base population of the study. Sample size was planned by TNCS project based on the aim of detecting events with a proportion of as low as 1% with a precision of +/-0.1%. i.e., a relative precision of +/-10%, for two-sided 95% confidence level. A sample of 50,200 RNs were randomly selected based on a stratified random sampling with probability proportional to the population of nurses of each 10-year age stratum. The questionnaires were sent via post following the random sampling technique. Of these, 18,198 posts could not be delivered due to incorrect address. Those who received questionnaires were 32,002.

Wave 1 occurred in 2009 and included a total of 18,756 respondents (58.6%). RNs whose job types were nursing in academia, nursing administration, unemployed, and/or student were excluded from this study. Thai RNs (n=13,754) who worked in the nursing service during the previous 12 months from the date of data collection were included in the analysis.

Wave 2 was the follow-up after 3 years (2012) and included 11,282 respondents (60.2%) from wave 1. For the analysis of wave 2, subjects who were formally working in the nursing services during the previous 12 months of wave 2 data collection and who responded to the wave 2 questionnaire included a total of 8,238 subjects. The final criteria of determining wave 2 included RNs who were formally considered RNs during both wave 1 and 2 (n=5,920).

This method was utilized in order to investigate the reduction of NSIs from wave 1 in 2009 and wave 2 in 2012. Lastly, our study included nurses from wave 1 who had been injured by a needle stick or sharp object (n=1,576) to determine the risk factors potentially associated with PNSIs

*Study variables*

The primary outcome of this study was experiencing NSIs or sharp objects caused by a primary duty during the prior 12 months of RNs. Those who were injured by a needle stick or sharp object in wave 1 and 2 were referred to having PNSIs. In this study, the independent variables were sex, age, technical training >4 months, marital status, types of workplace, part-time job, work shift, and the number of shifts worked during the 9:00 p.m. - 7:00 a.m. night shift per month.

*Statistical analysis*

STATA version 13 (Stata Corp, College Station, TX) was used for data analysis. Descriptive analysis was presented through percentage, mean (standard deviation), and median. The incidence of NSIs per person-years was calculated by summing the total number of NSIs during the previous 12 months of data collection during both wave 1 and 2. McNemar's test was used to investigate the NSIs that were associated between wave 1 and 2. Logistic regression analysis was used to examine the risk factors for PNSIs by adjusted OR with 95% confidence interval (95% CI). The significance level was set at 0.05.

*Ethics Approval*

This study was approved by the KhonKaen University Ethics Committee in human research (Reference No. HE582085). TNCS project was approved by the Human Research and Ethics Committee of

the Ministry of Public Health, Thailand (Reference No. 51/2552).

## Results

*Incidence of needle stick and sharp injuries*

Baseline characteristics of the sample in wave 1 (n=13,754) are presented in Table 1. Almost all were female (96.4%) with a mean age of 41.6 years (SD = 9.4). The majority of nurses worked in a hospital (83.4%) and day shift hours (48.2%).

The incidence of NSIs during the 12 months before data collection was 0.27 per person-years (95% CI= 0.26-0.28) (Table 2). The majority of NSI

**Table 1** Percentage of registered nurses by baseline characteristics in Thailand, 2009

| Factors | Number | Percent |
|---|---|---|
| **Sex** | | |
| Female | 13,192 | 96.4 |
| Male | 488 | 3.6 |
| **Age (years)** | | |
| 20-29 | 1,563 | 12.4 |
| 30-39 | 3,465 | 27.6 |
| 40-49 | 4,629 | 36.9 |
| 50+ | 2,904 | 23.1 |
| Mean (SD); 41.6(9.4) | | |
| (Min : Max); (20.5 : 65.4) | | |
| **Technical training > 4 months** | | |
| No | 9,183 | 67.4 |
| Yes | 4,444 | 32.6 |
| **Marital status** | | |
| Married | 8,230 | 60.1 |
| Single/ widowed/ divorced/ separated | 5,473 | 39.9 |
| **Types of workplace** | | |
| Hospital | 10,969 | 83.4 |
| District health promoting hospital | 1,366 | 10.4 |
| Other | 821 | 6.2 |
| **Others work (part time)** | | |
| No | 9,955 | 77.6 |
| Yes | 2,865 | 22.4 |
| **Work shift** | | |
| Day shift | 6,428 | 48.2 |
| Both day shift and night shift rotation | 3,534 | 26.5 |
| No shift work | 1,977 | 14.9 |
| Night shift | 1,389 | 10.4 |

**Table 2** The incidence of needle stick and sharp injuries per nurse years for wave 1 and wave 2

| Factors | Wave 1 (2009) | | | | | Wave 2 (2012) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | n | Person-years | n of event | Incidence Per person-year | 95%CI | n | Person-years | n of event | Incidence Per person-year | 95%CI |
| Overall | 13,754 | 12,733.4 | 3,565 | 0.27 | 0.26-0.28 | 8,238 | 6,936.7 | 1,208 | 0.17 | 0.16-0.18 |
| **Sex** | | | | | | | | | | |
| Female | 13,192 | 12,231 | 3,427 | 0.27 | 0.26-0.28 | 7,899 | 6,656.8 | 1,152 | 0.17 | 0.16-0.18 |
| Male | 488 | 441.4 | 118 | 0.26 | 0.22-0.32 | 237 | 199.9 | 41 | 0.21 | 0.15-0.28 |
| **Technical training > 4 months** | | | | | | | | | | |
| No | 9,183 | 8,524.1 | 2,538 | 0.29 | 0.28-0.30 | 7,018 | 5,921.9 | 1,047 | 0.18 | 0.17-0.19 |
| Yes | 4,444 | 4,103.7 | 1,002 | 0.24 | 0.22-0.25 | 1,159 | 976.4 | 154 | 0.16 | 0.13-0.18 |
| **Marital status** | | | | | | | | | | |
| Single/ widowed/ divorced/ separated | 5,473 | 4,966.8 | 1,775 | 0.35 | 0.33-0.37 | 3,115 | 2,602.0 | 553 | 0.21 | 0.20-0.23 |
| Married | 8,230 | 7,719.5 | 1,777 | 0.23 | 0.22-0.24 | 5,079 | 4,309.4 | 648 | 0.15 | 0.14-0.16 |
| **Types of workplace** | | | | | | | | | | |
| District health promoting hospital | 1,366 | 1,303.4 | 388 | 0.30 | 0.27-0.33 | 562 | 504.8 | 109 | 0.22 | 0.18-0.26 |
| Hospital | 10,969 | 10,332 | 2,896 | 0.28 | 0.27-0.29 | 7,029 | 5,997.9 | 1,034 | 0.17 | 0.16-0.18 |
| Other | 821 | 557.4 | 140 | 0.20 | 0.17-0.25 | 453 | 333.9 | 46 | 0.14 | 0.10-0.18 |
| **Others work (part time)** | | | | | | | | | | |
| No | 9,955 | 9,179.7 | 2,450 | 0.26 | 0.25-0.27 | 5,534 | 4,714.2 | 754 | 0.16 | 0.15-0.17 |
| Yes | 2,865 | 2,692.3 | 897 | 0.33 | 0.31-0.35 | 2,427 | 2,061.5 | 423 | 0.21 | 0.19-0.23 |
| **Shift work** | | | | | | | | | | |
| Night shift | 1,389 | 1,327.9 | 553 | 0.41 | 0.38-0.45 | - | - | - | - | - |
| Both day shift and night shift rotation | 3,534 | 3,343.4 | 1,309 | 0.39 | 0.37-0.41 | 2,777 | 2,417.5 | 632 | 0.26 | 0.24-0.28 |
| Day shift / no shift work | 8,405 | 7,724.3 | 1,608 | 0.20 | 0.19-0.21 | 5,272 | 4,408.5 | 559 | 0.13 | 0.12-0.14 |
| **Number of shifts worked 9.00 pm-7.00 am per month** | | | | | | | | | | |
| > 16 shifts per month | - | - | - | - | - | 238 | 204.8 | 66 | 0.32 | 0.25-0.41 |
| 13-16 shifts per month | - | - | - | - | - | 496 | 439.1 | 122 | 0.28 | 0.23-0.33 |
| 9-12 shifts per month | - | - | - | - | - | 694 | 610.9 | 165 | 0.27 | 0.23-0.31 |
| 5-8 shifts per month | - | - | - | - | - | 715 | 630.5 | 152 | 0.24 | 0.20-0.28 |
| 1-4 shifts per month | - | - | - | - | - | 713 | 617.3 | 113 | 0.18 | 0.15-0.22 |
| 0 shifts per month | - | - | - | - | - | 5,134 | 4,318.6 | 568 | 0.13 | 0.12-0.14 |

incidence (per person-years) included: women (0.27, 95%CI= 0.26-0.28); those who did not receive any technical training for more than 4 months (0.29, 95%CI= 0.28-0.30); those who were single, widowed, divorced, or separated (0.35, 95%CI= 0.33-0.37); those who worked in a district health promoting hospital (0.30, 95%CI= 0.27-0.33); had part-time jobs (0.33, 95%CI= 0.31-0.35); and worked the night shift (0.41, 95%CI= 0.38-0.45).

In wave 2 only a sample of 8,238 was obtained and NSI rates were 0.17 per person-years (95% CI= 0.16-0.18). The incidence rate for NSIs stratified by group demonstrated that the majority of the NSI incidence at follow-up (per person-years) included: men (0.21, 95%CI= 0.15-0.28); those with no any technical training more than 4 months (0.18, 95%CI= 0.17-0.19); those who reported being single, widowed, divorced, or separated (0.21, 95% CI= 0.20-0.23); worked in a district health promoting hospital (0.22, 95%CI= 0.18-0.26); had a part-time job (0.21, 95%CI= 0.19-0.23); both day shift and night shift rotation (0.26, 95%CI= 0.24-0.28); and worked the night shift (9:00 p.m. – 7:00 a.m.) more than 16 session per month(0.32, 95%CI= 0.25-0.41) as shown in Table 2.

*Factors associated with persistent NSIs.*

There was a 48% reduction in the number of NSIs from wave 1 to wave 2 (Table 3).The odds of this reduction from wave 1 and 2 was statistically significant (OR = 0.52; 95%CI= 0.47-0.57).

The results from the logistic regression regarding the risk factors associated to PNSIs are presented in Table 4. In the crude analysis, five variables were found to be statistically significant risk factors of PNSIs: age; marital status; having a part-time job; shift work; and the frequency of taking night shifts (between 9:00 p.m. and 7:00 a.m. per month). The results from the multiple logistic regression reported three variables as statistically significant risk factors for PNSIs: marital status; having a part-time job; and the number of night shifts worked between 9:00 p.m. and 7:00 a.m. in a month. There is the gradient effects of the intensity of taking nightshift and the incidence of PNSI; where the strongest risk factor associated to PNSIs was working night shift for more than 16 sessions in a month (Adj OR = 3.20; 95%CI= 1.70-6.00).

## Discussion

*Key findings*

This is the first study to present the incidence of NSIs over time, 0.27 per person-years (95%CI= 0.26-0.28), and examined an association between NSIs in RNs from a cohort study with wave 1 to wave 2. The incidence rate of NSIs during wave 1 related to the odds of the incidence rate in NSIs during wave 2. Nearly half of the RNs in this study could prevent NSIs. A principal finding from our study was that Thai RNs are at substantial risk for NSIs when working night shift hours between 9:00 pm to 7:00 am, more than 16 times per month.

The incidence rates of NSIs in developing countries and regions, such as: Iran[13] and Sub-Saharan Africa[15],were higher than developed countries, such as: Japan[12], France[27], the United States[11], and Australia[10]. The incidence rate of NSIs in our study was 0.27 per person-years (95% CI= 0.26-0.28), higher than similar studies conducted in the United States that reported 0.11 per HCWs and in Saudi Arabia with 0.038 per HCWs per year[5,28]. The study

**Table 3** Odds ratio of the NSIs that were associated between wave 1 and 2

| Events | Number (Wave 1) | Number (Wave 2) | Changes between waves (Wave 2-Wave 1) | 95%CI | P-value |
|---|---|---|---|---|---|
| Number of NSIs | 1,377 | 827 | | | |
| Total number of nurses | 5,072 | 5,072 | | | |
| Percent of NSIs | 27.1 | 16.3 | | | |
| Odds ratio | | | 0.52 | 0.47 to 0.57 | <0.001 |

**Table 4** Multiple logistic regression for risk factors of persistent needle stick and sharp injuries (PNSIs)

| Factors | n | % PNSIs | Crude OR | Adjusted OR | 95%CI | P-value |
|---|---|---|---|---|---|---|
| Overall | 1,576 | 17.4 | | | | |
| **Marital status** | 1,498 | | | | | 0.004 |
| Others | 589 | 21.1 | 1.60 | 1.50 | 1.10-1.90 | 0.003 |
| Married | 909 | 14.5 | 1 | 1 | | |
| **Part-time job** | 1,467 | | | | | 0.004 |
| No | 1,005 | 15.1 | 0.60 | 0.60 | 0.40-0.80 | 0.001 |
| Yes | 462 | 21.9 | 1 | 1 | | |
| **Number of shifts worked 9.00 pm-7.00 am per month** | 1,472 | | | | | <0.001 |
| > 16 shifts per month | 52 | 34.6 | 3.60 | 3.20 | 1.70-6.00 | <0.001 |
| 13-16 shifts per month | 89 | 29.2 | 2.80 | 2.50 | 1.50-4.10 | 0.001 |
| 9-12 shifts per month | 123 | 25.2 | 2.30 | 2.10 | 1.30-3.30 | <0.001 |
| 5-8 shifts per month | 143 | 20.9 | 1.80 | 1.70 | 1.10-2.60 | 0.034 |
| 1-4 shifts per month | 155 | 18.1 | 1.50 | 1.40 | 0.90-2.20 | 0.066 |
| 0 shifts per month | 910 | 12.9 | 1 | 1 | | |
| **Age (years)** | 1,457 | | | - | | |
| 20-29 | 259 | 19.1 | 1.2 | | | |
| 30-39 | 476 | 17.9 | 1.1 | | | |
| 40-49 | 436 | 16.8 | 1.0 | | | |
| 50+ | 286 | 16.5 | 1 | | | |
| **Shift work** | 1,523 | | | - | | |
| Both day shift and night shift rotation | 516 | 25.3 | 2.2 | | | |
| Day shift / no shift work | 1007 | 13.3 | 1 | | | |

conducted in the United States reports an incidence rate of 43%, an underestimate possibly due to their self-administered questionnaires that included questions such as, "Have you ever been injured by a needle stick or sharp object in the past 12 months?". Responses may have resulted in under-reportings since one person may have experienced more than one NSI, creating a knowledge gap regarding NSI frequency and persistent NSIs.

Our findings were consistent with a the United States study in that working the night shift was associated with an increased risk of NSI by 1.59 (95%CI= 1.20-2.11)[22]. A typical RN hospital position provides three different eight-hour shifts that covers a full day (24-hour) and this has been found to cause an intense feeling of fatigue[29].

Smith et al. (2006) reported that nurses who experienced significant fatigue after work were 1.87 times more likely to sustain multiple NSIs[12]. Additionally a Turkish hospital showed that the factors significant increasing the rate of NSIs were working for more than 8 hours/day[30]. A Korean study showed that working a mixed shift (day shifts followed by night shifts, or vice versa) was associated with a 4 times increased risk (compared with day-only) and 4.4 times (compared with night-only)[21].

Performing shift work has been identified as the main cause of error from service nurses. Marias DJ et al. (1996) found that NSIs increased during specific shift times, particularly the first and last 2 hours of a shift[31]. The emergency room and In-Patient Department report the most NSIs in hospital RNs[32], likely due to tense emergency environments and situations. Short staffing at shift level results in a disparity in patient-to-nurse ratio, which is also associated with the risk of NSIs[20]. The World Bank reported that in 2010, Thailand had 2.1 RNs for every 1,000 people, which is fewer than the United States (9.8); Australia (9.6); Singapore (6.4); and Japan (10.9)[33]. The shortage of registered nurses is an issue worldwide that can exacerbate this issue of increasing number of day and night shift hours worked[34].

*Strengths and Weaknesses*

This study was part of the TNCS project by using the most sample groups that ever been studied in developing countries. The tools used for this study were created for several research purposes, which were not specific to the investigation in this particular study alone. Although the dependent variable questioned "Have you ever been injured by a needle stick or sharp object in the past 12 months?" it was found that a quarter of nurses in Thailand had ever been injured by a needle stick or sharp object in the past 12 months. Comparing with the other researches using number of episode, the lower number in this research than the actual one could be a weak point. There were also other related factors such as the practice of universal precaution, emotional exhaustion, work environment, fatigue excluded in this study because this research was conducted and analyzed data obtained from TNCS project database. The area of NSIs will be attentively observed and analyzed in the further research.

## Recommendations

Avoiding shift work is impracticable in the nursing career, therefore we suggest that the number of night shifts worked per RN be reduced in order to decrease fatigue. We also suggest a monitoring

system over RN health and well-being; and a better support system aimed at promoting healthy work environments. RNs in Thailand should take precautions in accident prevention by being aware of established work shift guidelines[32].

Future surveys included in TNCS may include questions in regards to persistent NSIs specifying RN safety training; modifiable risk factors; use of safety equipment; and factors related to fatigue such as sleep quality and quantity.

In conclusion, our study revealed issues behind NSIs among RNs in Thailand. One-fourth of the RNs in Thailand experienced NSIs in the past 12-months and after a 3-year follow up, approximately half of them prevented future NSIs through improved awareness about the issue. The incidence of PNSIs was associated with marital status, having apart-time job, and the number of night shifts (9:00 p.m. - 7:00 a.m.) worked per month. Therefore, in order to decrease the number of PNSIs, hospitals should implement strategies to prevent injuries, such as monitoring and reporting systems at the national level. Future studies must identify and establish the factors associated with persistent NSIs in the hospital setting to strengthen guidelines and prevent NSIs altogether.

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