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Self-reported unsafe medication behaviour among clinical nurses in China: A nationwide survey

Ning Qin[1,2] | Shuangjiao Shi[1] | Yinglong Duan[1] | Zhuqing Zhong[1,2] | Guliang Xiang[1,3]

[1]Nursing Department, The Third Xiangya Hospital, Central South University, Changsha, China

[2]Xiangya Nursing School, Central South University, Changsha, China

[3]Department of Nuclear Medicine, The Third Xiangya Hospital, Central South University, Changsha, China

Correspondence
Guliang Xiang, Department of Nuclear Medicine, The Third Xiangya Hospital, Central South University, 138 Tongzipo Road, Yinpenling Street, Yuelu District, Changsha, China.
Email: xiangguliang@126.com

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Abstract

Aim: Unsafe medication behaviour was the direct cause of medication error, while the current status of unsafe medication behaviour among Chinese clinical nurses remains uncertain. To investigate unsafe medication behaviour among Chinese nurses and to analyse its associated factors.

Design: A cross-sectional online study was conducted in 31 provinces and municipalities of mainland China.

Methods: The electronic self-administered questionnaire was used to collect data from July–August 2020, including demographic information (age, gender, initial degree, ultimate education degree, hospital levels, unit nature, professional position, duty, departments, working years and working regions) and an adapted nurse unsafe medication behaviour scale measuring self-reported nurse unsafe medication behaviour (SR-NUMB). A generalized linear mixed model was applied to determine the influencing factors.

Results: A total of 10,153 Chinese nurses responded online, and 7,873 responses that met the time control requirements were included finally. It turned out that 80.49% of Chinese nurses had SR-NUMB. Specifically, 72.81% of them had unsafe medication behaviours in the process of medication administration, followed by medication monitoring (53.09%), medication preservation and dispensing (47.42%), and medical order processing (44.53%). A generalized linear mixed model demonstrated that male nurses and nurses who work in secondary hospitals or general hospitals, those who have higher professional positions or duties, those who have been working for 5–10 years, and those who are working in emergency and intensive critical units may have higher level of SR-NUMB compared to other nurses.

Conclusion: Suboptimal SR-NUMB among Chinese nurses was identified in our findings. Associated factors, such as gender, hospital levels, unit nature, professional position, duty, working years and departments, should be targeted in future prevention and intervention efforts for safe medication management among Chinese nurses.

KEYWORDS
clinical practice, medication safety, nurse, self-reported, unsafe medication behaviour

1 | INTRODUCTION

Medication errors are preventable events in the drug treatment process in hospitals (Goedecke, Ord, Newbould, Brosch, & Arlett, 2016). There is a relatively high incidence of medication errors in hospitals. In Australia, 1.05 medication errors were found in every 100 admitted patients (Isaacs et al., 2020). Approximately 10% of all medication orders are reported with errors in the Middle East (Thomas et al., 2019). In addition, a higher error rate (39.1%) has been identified in Vietnam (Nguyen, Nguyen, van den Heuvel, Haaijer-Ruskamp, & Taxis, 2015). Although most medication errors were no harm, there are a few that may result in serious outcomes or even death. Based on the model of Human error developed by Professor Reason, unsafe medication behaviour, such as non-compliance with standard medical or nursing procedures, was the direct cause of medication errors and may lead to clinical adverse events ultimately (Reason, 1995). Therefore, medication safety behaviour is one of the important indicators to improve medication errors for managers.

Nurses play an important role in the process of medication management and execution of prescriptions or orders. A systematic review indicated that the rate of errors in nurse medication management reached 39.3% (Bifftu & Mekonnen, 2020). However, due to multiple obstacles (e.g., personal, professional and organization barriers), the medication error reporting was inadequate making it difficult to identify the prevalence of medication errors (Vrbnjak, Denieffe, O'Gorman, & Pajnkihar, 2016). Bagheri et al (Bagheri, 2017) pointed out that fear over being blamed by doctors was the least important reason behind suboptimal reports of medication errors from nurses' perspectives in Iran. However, in China, the fear of being punished for from the negative consequences of medication errors is an important reason for nurses to avoid reporting nursing errors. Face-saving (an action designed not to cause embarrassment or look stupid to a person) and power discrepancy (different level of acceptance for nurses who have inferior power in the hospital) are the two most important cultural factors associated with underreported medication error in China (Yang et al., 2020).Therefore, it is much more difficult to identify the actual medication error rate in China because of these special cultural factors. Prior studies collected data from medication error reporting systems (Hutchinson et al., 2020; Shiima, Malik, & Okorie, 2021; Tyynismaa, Honkala, Airaksinen, Shermock, & Lehtonen, 2021), which might be underreported. While in the present study, nurse unsafe medication behaviour (NUMB) scale was used for collecting the self-reported unsafe medication behaviour for nurses anonymously, it included clinical scenarios about nursing work procedures, such as executing doctor's orders incorrectly and using medications that do not meet regulations. Therefore, it was more likely to acquire actual information about nurse medication use and reflect the causes of medication errors directly (Ulas et al., 2015; Yu, Li, Gao, Liu, & Lin, 2018).

The definition of NUMB is proposed as "unsafe nursing practices that might cause medication errors when nurses administering medication" (Yu, Lin, Lyu, Gao, & Liu, 2018). NUMB could occur in any aspect in the medication administration process, which can be divided into four domains, i.e., unsafe behaviour in processing medication orders, unsafe behaviour in preserving, dispensing and disposing medication, unsafe behaviour in administrating medication and unsafe behaviour in monitoring medication reactions. NUMB was a major contributor to adverse medication events (i.e., exacerbations of diseases and adverse outcomes) and increasing economic burden. A report on national burden in the United States showed that preventable adverse medication consequences associated with inpatient injectable medications increased the annual patient costs by $2.7 billion to $5.1 billion, averaging $600,000 in extra costs per hospital, and medical professional liability costs were approximately $300 million to $610 million annually, with an average cost of $72,000 per hospital (Lahue et al., 2012). As a specific example, when processing medical orders, the dosage of anticoagulant was reduced, the nurses failed to check it carefully, but still followed the original dosage. Patients may have an increased risk of haemorrhage making treatment more complex and more expensive. Meanwhile, medical claims followed. In this specific situation, the medication error should have been identified and it is important to remind us of taking specific preventive measures when processing medication orders.

To date, there are some studies that have estimated the prevalence of medication errors in specific hospitals or departments, especially tertiary general hospitals and paediatrics, while nurses are not the subjects investigated (Alghamdi, Keers, Sutherland, & Ashcroft, 2019; Ewig, Cheung, Kam, Wong, & Knoderer, 2017; Feinstein, Pannunzio, & Castro, 2018). There were two national reports (i.e., England and Wales and Malaysia) that surveyed all the medication errors nationwide, but neither study reported nurse-related medication errors or unsafe behaviour (Cousins, Gerrett, & Warner, 2012; Samsiah, Othman, Jamshed, Hassali, & Wan-Mohaina, 2016). An observational study reported a 12.8% of medication errors about intravenous infusion among Chinese nurses, though, it was a small sample size study (Ding et al., 2015). Until now, only one study has investigated self-reported NUMB (SR-NUMB), which was conducted in the city of Harbin, China (Yu et al., 2018). However, given the very large discrepancy in the distribution of medical resources in different regions of China, as well as varying levels of nursing care in different ranking levels of hospitals in China, the investigation of the SR-NUMB in only one city cannot reflect the overall medication error status in China. Thus far, there have been no studies with a national sample examining the status of SR-NUMB among Chinese nurses.

A study of influence path on SR-NUMB showed that nurse personal factors, i.e., pharmaceutical knowledge, skills, awareness of medication safety and professional position, software, and liveware plays a mediating role in the relationship between SR-NUMB and the environment. In addition, one study indicated that the higher professional position is, the worse the performance of SR-NUMB is among Chinese nurses (Yu, Li, Gao, Liu, & Lin, 2018). However, there seems to be a contradiction about professional position. A web survey among Italian midwives indicated that nurses with inadequate working experience are at a higher risk of medication errors (Cappadona

et al., 2020). Therefore, more studies need to be conducted to identify the effect of professional position on NUMB. Furthermore, hospital levels and the type of unit nature are closely related to the work environment, which may be the potential influencing factors. At the same time, identifying the level of SR-NUMB in different regions and hospitals has great significance to the regionalized management of medication safety.

Therefore, the present study was carried out as the first nationwide online survey of Chinese nurses, and it captured a variety of demographics that had never been discussed, including professional position, work province, hospital levels and unit nature. This research aims to examine the status of SR-NUMB and to identify the influencing factors among nurses in China, in order to provide a basis for making strategies to improve clinical medication administration management.

2 | METHODS

2.1 | Sample

This nationwide cross-sectional study using an online survey method was conducted in China. Convenience sampling was used to recruit participants from July to August 2020. The eligibility criteria for the participants were as follows: (a) age ≥18 years, (b) Chinese registered nurse, (c) work at hospital currently and (d) born in China as Chinese citizen. Sojump (URL: https://www.wjx.cn/), a professional, low-cost, high-efficiency and high-quality online survey platform, was used to collect data. Thanks to the assistance of the Chinese nursing association, the QR code and weblink of the questionnaire were sent out via WeChat groups, and qualified participants were reminded to engage in the study. After the informed consent form was agreed upon, an anonymous method (name and hospital name were not involved) was adopted during completing the questionnaire and the data were used only for scientific research. The privacy and data security were protected. To guarantee the data quality, the answer time was limited from 300 seconds to 3,000 seconds. A total of 10,153 Chinese nurses consented to participate in the survey; however, 2,149 nurses spent less than 300 seconds filling out the questionnaire, and 131 nurses spent more than 3,000 seconds. Finally, an effective response rate of 77.54% (7873) was obtained.

2.2 | Instruments

We collected basic demographic characteristics of age, gender, initial degree, ultimate education degree, hospital levels, unit nature, professional position, duty, departments, working years and working regions. Age (1 = ≤20 years old, 2 = 20–30 years old, 3 = 30–40 years old, 4 = 40–50 years old, 5 => 50 years old) and working years (1 = ≤5 years, 2 = 5–10 years, 3 = 10–15 years, 4 = 15–20 years, 5 => 20 years) were divided into 5 groups. The participants were divided into 7 groups according to regional disparity in China (1 = eastern, 2 = south, 3 = central, 4 = north, 5 = northwest, 6 = southwest, 7 = northeast).

The NUMB scale (Yu, Li, Gao, Liu, & Lin, 2018) was adapted slightly to meet the study needs and was used to investigate the SR-NUMB in our study. In our research, the adapted scale (Appendix S1) consisted of 26 items with a 5-point Likert scale response (1 = never, 2 = seldom, 3 = sometimes, 4 = often, 5 = always), it was confirmed with good reliability and validity. Four domains were included in the scale: medication monitoring (9 items), medication preservation and dispensing (7 items), medication administration (7 items), and medical order processing (3 items). The Cronbach's α coefficient and split-half for the scale were 0.933 and 0.823. Weight via principal component analysis method was utilized to calculate the total score, ranging from 26 to 130. Higher scores indicate higher levels of NUMB. If participants scored 26, they were put into the non-SR-NUMB group, the others were put into the SR-NUMB group. The percentage of SR-NUMB was calculated by the number of nurses who scored >26 divided by the total number of nurses. For the four domains, the percentage of non-SR-NUMB was calculated by the number of nurses who answered "never" for any questions in each domain divided by the total number of nurses.

2.3 | Data analysis

Data analysis was performed by IBM SPSS Statistics 25 (IBM Corp, US). The normal distribution of the data was assessed by the Kolmogorov–Smirnov test. Continuous variables are reported as the mean ± standard deviation (SD) for normal data or are reported as the median (25th percentile—75th percentile) for non-normal data. Categorical variables are described as frequency and percentage. A chi-squared test was conducted to compare the percentage of SR-NUMB in the different regions of China. Pairwise comparison was performed by the Bonferroni method. For the non-normal distribution of SR-NUMB score, the random effects in different areas were taken into account, we applied a generalized linear mixed model to determine the factors associated with SR-NUMB using regions as a random variable and other demographic variables as fixed variables. The least significant difference method (LSD) was performed for pairwise comparisons among groups. A two-tailed $p \leq .05$ was considered significant for the planned analysis.

2.4 | Ethics statement

The study was approved by the Ethics Committee of a hospital (No. I 20030). The purpose of the study and confidentiality statement were presented on the electric questionnaire homepage. Thus, those who completed the questionnaire were considered consenting to participate in the study. For the data security, we collected data involving no personal name and specific hospital name. We promised that collected data were used only for scientific analyses.

3 | RESULTS

3.1 | Sample demographic characteristics

The final sample consisted of 7,873 nurses from 31 provinces and municipalities of mainland China. The eastern region recorded 12.65%, the southern region11.27%, the central region 35.15%, the northern region 9.53%, the northwest region 17.97%, the southwest region 5.74% and the north-eastern region 7.70%. Most of our participants were female, had a bachelor's degree, worked in tertiary hospitals, had no administrative duties, and had an average age of 31.91 ± 6.60 years (ranging from 19 to 60 years). In addition, the average working years was 10.19 ± 7.22 years (Table 1).

3.2 | The status of SR-NUMB

The percentage of SR-NUMB among Chinese nurses was 80.49%, and the total average score was 33.15 (27.16–41.84). The percentages of SR-NUMB for each domain were 53.09%, 47.42%, 72.81% and 44.53%. The percentages of SR-NUMB in the seven regions were 80.02%, 85.68%, 83.05%, 74.13%, 80.42%, 84.96% and 66.67%, respectively (Table 2). The chi-squared results showed significant difference on SR-NUMB in different regions ($\chi^2 = 125.70$, $p < .001$). The pairwise comparison results showed there were significant differences between groups as follows: eastern vs south, eastern vs northeast, south vs north, south vs northwest, south vs northeast, central vs north, central vs northeast, north vs northwest, north vs southwest, northwest vs northeast and southwest vs northeast. The average score in the SR-NUMB group was 36.13 (30.39–44.34), the percentages and average scores for each domain of the SR-NUMB scale were 65.96%, 58.91%, 90.45%, 55.33% and 10.35 (8.46–13.48), 8.13 (7.05–10.62), 12.34 (9.87–15.49), 3.64 (2.74–6.34), respectively. The results of each item are shown in Appendix S2.

3.3 | The influencing factors of SR-NUMB

As seen in Table 3, gender, hospital levels, unit nature, professional position, duty, working years and departments were the influencing factors of SR-NUMB. As a random effect, there was no significant difference in SR-NUMB among the various regions. Male nurses had higher level of SR-NUMB than female nurses (95% CI 0.93, 4.31). Nurses working in secondary hospitals (95% CI 1.71, 0.38) or general hospitals (95% CI 1.71, 0.38) had higher level of SR-NUMB. Regarding professional position, it seems that nurses with a higher professional position may have higher level of SR-NUMB. For duty, there were lower level of SR-NUMB for nurses who had shift duty in a clinical department than for those who only had administrative duty, such as nursing supervisors (95% CI 4.46, 6.38), head nurses (95% CI 4.40, 9.56) or directors of nursing (95% CI 0.43, 10.44). Regarding departments, nurses working in operation rooms seemed to have a lower level of SR-NUMB. In addition, compared with those who have worked for 15–20 years, nurses who have worked for 5–10 years were more likely to have a lower level of SR-NUMB.

4 | DISCUSSION

Our results highlighted the high percentage of nurses who had SR-NUMB in China. Differences in the percentages of SR-NUMB in seven regions were found. Thus, nursing medication safety management measures need to be implemented taking the regional discrepancy into consideration. The results suggested that male nurses, working in secondary hospitals or general hospitals, with a higher professional position or with only administrative duty, having 5–10 years of working experience, and working in a common ward or emergency and intensive critical units were independent risk factors for high level of SR- NUMB. The contribution of this study is that there is a relationship between SR-NUMB and the different regions, hospitals of different scales, and nurses with varying characteristics based on a nationwide sample. This study is relevant to the development of strategies for medication safety training.

This study included 7,873 Chinese nurses across the seven regions of China, covering 31 provinces and municipalities of mainland China except for the autonomous regions of Hong Kong, Macao and Taiwan. There were 5 provinces with more than 500 samples, namely, the Hunan, Xinjiang, Shandong, Henan, and Guangdong Provinces. The largest sample size in the study was collected from the central regions (including Hunan Province) in China. This tailed exactly with the largest population base of the central regions of China. The percentage of SR-NUMB was at a high level across the seven regions, ranging from 66.67% to 85.68%. 74.30% SR-NUMB in the tertiary hospitals of the city of Harbin was identified in a previous study (Yu, Lin, Lyu, Gao, & Liu, 2018). It was lower than the nationwide level (80.49%) while higher than that of the northeast region (66.67%) in the present study. We also found that regional differences revealed a higher percentage of SR-NUMB in the southern area (85.68%) and a lower percentage in the northeast of China (66.67%). It might be related to the differences in workload for nurses, the level of pharmacy knowledge, and medication management quality across regions (Escrivá Gracia, Brage Serrano, & Fernández Garrido, 2019; Feleke, Mulatu, & Yesmaw, 2015; Magalhães, Kreling, Chaves, Pasin, & Castilho, 2019). Thus, it is necessary to carry out regionalized medication safety training measures for nurses based on regional differences.

Our results also demonstrated that nurses had the highest percentage of SR-NUMB in terms of medication administration (72.81%). Meanwhile, a higher percentage (90.45%) was found in the SR-NUMB group, which is in line with previous research. More than four-fifths of nurses made mistakes during medication preparation and administration in a previous study (Ulas et al., 2015). The reasons for unsafe behaviour in terms of medication administration could be considered as follows: lack of adequate training for safe medication administration, non-compliance with guidelines, inadequate work experience, the occurrence of unplanned

TABLE 1 Demographic characteristics of SR-NUMB (N = 7,873)

Characteristics	*N* (%)	SR-NUMB score	Domain 1	Domain 2	Domain 3	Domain 4
Gender						
Male	178 (2.26%)	33.43 (27.97–42.48)	11.37 (8.46–13.08)	9.69 (7.05–10.58)	12.00 (7.74–13.44)	4.83 (2.74–6.34)
Female	7,695 (97.74%)	33.13 (27.16–41.82)	11.01 (8.46–12.44)	8.93 (7.05–10.10)	12.12 (7.74–15.00)	4.24 (2.74–5.44)
Age						
≤20 years old	28 (0.36%)	32.30 (26.00–42.16)	11.67 (8.46–12.61)	9.33 (7.05–9.14)	12.03 (7.74–14.18)	5.23 (2.74–7.04)
20–30 years old	3,891 (49.42%)	32.00 (27.00–40.28)	10.76 (8.46–12.17)	8.81 (7.05–9.29)	11.64 (7.74–14.32)	4.28 (2.74–5.49)
30–40 years old	3,102 (39.40%)	33.98 (28.07–42.72)	11.14 (8.46–13.07)	9.04 (7.05–10.25)	12.41 (8.71–15.35)	4.24 (2.74–5.45)
40–50 years old	789 (10.02%)	36.13 (29.42–45.09)	11.70 (8.46–14.12)	9.23 (7.05–10.92)	13.29 (9.68–16.38)	4.15 (2.74–4.64)
>50 years old	63 (0.80%)	34.40 (28.13–44.28)	11.39 (8.46–12.66)	9.43 (7.05–11.38)	13.06 (9.68–16.45)	4.08 (2.74–5.49)
Initial degree						
Secondary education	1930 (24.51%)	33.91 (28.04–43.35)	11.35 (8.46–13.26)	9.14 (7.05–10.30)	12.52 (7.74–15.49)	4.16 (2.74–4.64)
College degree	3,488 (44.30%)	32.27 (27.11–40.49)	10.77 (8.46–12.23)	8.82 (7.05–9.29)	11.80 (7.74–14.36)	4.24 (2.74–5.49)
Bachelor degree	2,421 (30.75%)	33.95 (28.04–42.32)	11.08 (8.46–12.55)	8.97 (7.05–10.16)	12.25 (7.74–15.24)	4.35 (2.74–5.49)
Graduate degree or above	34 (0.43%)	33.29 (29.60–44.20)	11.81 (8.46–13.96)	8.89 (7.05–9.47)	13.24 (7.74–18.05)	4.28 (2.74–6.34)
Ultimate education degree						
Secondary education	101 (1.28%)	30.20 (26.00–39.51)	10.87 (8.46–12.14)	9.08 (7.05–10.10)	11.45 (7.74–14.19)	3.87 (2.74–3.74)
College degree	2066 (26.24%)	32.18 (27.07–41.14)	10.97 (8.46–12.31)	8.98 (7.05–10.09)	11.78 (7.74–14.34)	4.26 (2.74–5.49)
Bachelor degree	5,626 (71.46%)	33.45 (27.93–42.05)	11.02 (8.46–12.52)	8.93 (7.05–10.10)	12.24 (7.74–15.25)	4.26 (2.74–5.49)
Graduate degree or above	80 (1.02%)	35.59 (29.86–43.93)	11.73 (8.46–13.14)	8.88 (7.05–10.14)	13.57 (9.89–15.49)	4.14 (2.74–5.30)
Hospital levels						
Tertiary hospital	5,894 (74.86%)	32.84 (27.16–41.20)	10.84 (8.46–12.29)	8.86 (7.05–9.98)	11.97 (7.74–14.43)	4.24 (2.74–5.44)
Secondary hospital	1888 (23.98%)	34.16 (28.11–44.21)	11.52 (8.46–13.56)	9.19 (8.46–13.56)	12.58 (8.71–15.49)	4.29 (2.74–5.49)
Community hospital	23 (0.29%)	36.89 (26.00–47.41)	12.75 (8.46–15.98)	9.70 (7.05–10.25)	13.23 (7.74–16.51)	3.58 (2.74–4.64)
Private hospital	68 (0.86%)	32.58 (27.96–40.37)	11.14 (8.46–13.09)	9.35 (7.05–10.37)	12.01 (7.74–13.46)	4.32 (2.74–5.49)
Unit nature						
General hospital	7,227 (91.79%)	33.36 (27.89–42.10)	11.07 (8.46–12.53)	8.98 (7.05–10.14)	12.20 (7.74–15.20)	4.28 (2.74–5.49)
Specialized hospital	646 (8.21%)	30.52 (26.00–38.58)	10.36 (8.46–11.40)	8.58 (7.05–9.15)	11.22 (7.74–13.38)	3.92 (2.74–4.64)
Professional position						
Nurse	1826 (23.19%)	30.99 (26.00–38.86)	10.71 (8.46–11.40)	8.82 (7.05–9.22)	11.28 (7.74–13.41)	4.24 (2.74–5.49)
Senior nurse	3,352 (42.58%)	32.31 (27.16–40.92)	10.80 (8.46–12.28)	8.80 (7.05–9.30)	11.83 (7.74–14.38)	4.25 (2.74–5.49)
Supervisor nurse	2,259 (28.69%)	35.11 (29.11–43.26)	11.28 (8.46–13.26)	9.08 (7.05–10.30)	12.79 (8.91–15.49)	4.21 (2.74–4.74)
Associate professor of nursing	384 (4.88%)	39.82 (32.21–49.53)	12.58 (8.46–15.24)	9.96 (7.05–12.02)	14.52 (10.89–17.56)	4.59 (2.74–6.14)

TABLE 1 (Continued)

Characteristics	*N* (%)	SR-NUMB score	Domain 1	Domain 2	Domain 3	Domain 4
Professor of nursing	52 (0.66%)	37.05 (31.46–47.38)	12.34 (8.69–15.17)	9.61 (7.05–11.33)	13.50 (10.91–16.25)	4.22 (2.74–4.72)
Duty						
None	6,876 (87.34%)	32.28 (27.11–40.51)	10.76 (8.46–12.21)	8.79 (7.05–9.29)	11.76 (7.74–14.36)	4.23 (2.74–5.44)
Nursing supervisor	880 (11.18%)	39.85 (32.54–48.88)	12.71 (9.32–15.20)	9.97 (7.05–11.54)	14.58 (11.01–17.51)	4.46 (2.74–5.49)
Head nurse	78 (0.99%)	41.96 (35.17–50.44)	13.06 (9.50–15.26)	10.40 (7.05–12.14)	15.13 (12.01–17.81)	4.70 (2.74–6.34)
Deputy head of nursing	18 (0.23%)	37.20 (29.21–47.34)	12.21 (9.21–15.23)	9.09 (7.05–11.12)	13.78 (9.57–18.69)	4.06 (2.74–3.97)
Director of nursing	21 (0.27%)	38.51 (34.30–50.09)	13.55 (10.39–16.06)	10.24 (7.98–11.81)	14.85 (12.10–17.55)	3.44 (2.74–3.69)
Working years						
≤5 years	2,202 (27.97%)	31.49 (26.00–39.41)	10.64 (8.46–11.51)	8.74 (7.05–9.23)	11.40 (7.74–14.07)	4.28 (2.74–5.49)
5–10 years	2,893 (36.75%)	32.95 (27.16–41.95)	10.97 (8.46–12.37)	8.96 (7.05–10.10)	12.07 (7.74–14.51)	4.26 (2.74–5.44)
10–15 years	1,278 (16.23%)	33.57 (27.97–42.06)	11.10 (8.46–12.73)	8.92 (7.05–10.04)	12.36 (8.71–15.30)	4.23 (2.74–5.44)
15–20 years	694 (8.81%)	35.14 (29.19–44.06)	11.32 (8.46–13.71)	9.19 (7.05–10.38)	12.74 (8.91–15.50)	4.30 (2.74–5.49)
>20 years	806 (10.24%)	36.30 (29.78–45.22)	11.80 (8.46–14.08)	9.31 (7.05–11.07)	13.36 (9.78–16.45)	4.17 (2.74–4.64)
Departments						
Common ward	5,446 (69.17%)	32.99 (27.16–41.89)	10.99 (8.46–12.45)	8.87 (7.05–10.01)	12.18 (7.74–15.25)	4.20 (2.74–5.39)
Emergency and intensive critical units	1825 (23.18%)	33.48 (27.87–41.76)	10.97 (8.46–12.37)	9.12 (7.05–10.25)	11.92 (7.74–14.41)	4.41 (2.74–6.14)
Operating room	99 (1.26%)	31.32 (26.94–40.21)	11.10 (8.46–12.15)	8.65 (7.05–10.02)	11.52 (7.74–13.36)	3.88 (2.74–4.64)
Others	503 (6.39%)	33.97 (28.10–42.58)	11.37 (8.46–13.09)	9.22 (7.05–10.15)	12.32 (7.74–15.24)	4.38 (2.74–5.54)
Regions						
Eastern	996 (12.65%)	32.72 (27.16–40.88)	10.68 (8.46–12.26)	8.55 (7.05–9.17)	1.93 (7.74–9.17)	4.20 (2.74–4.74)
South	887 (11.27%)	35.18 (29.14–44.42)	11.46 (8.46–13.42)	9.21 (7.05–10.35)	12.72 (8.85–15.49)	4.61 (2.74–6.34)
Central	2,767 (35.15%)	33.75 (28.13–42.70)	11.18 (8.46–13.05)	9.01 (7.05–10.25)	12.35 (8.71–15.38)	4.29 (2.74–5.49)
North	750 (9.53%)	30.74 (26.00–38.56)	10.44 (8.46–11.36)	8.64 (7.05–9.17)	11.45 (7.74–14.11)	3.92 (2.74–4.64)
Northwest	1,415 (17.97%)	33.71 (27.89–42.45)	11.32 (8.46–13.07)	9.25 (7.05–10.21)	12.29 (7.74–15.30)	4.30 (2.74–5.44)
Southwest	452 (5.74%)	33.48 (28.25–42.09)	11.04 (8.46–12.24)	9.13 (7.05–10.27)	12.35 (8.82–14.52)	4.41 (2.74–6.14)
Northeast	606 (7.70%)	29.43 (26.00–37.32)	10.14 (8.46–10.50)	8.44 (7.05–8.98)	10.79 (7.74–12.35)	3.86 (2.74–4.50)

Note: Domain1, medication monitoring; Domain2, medication preservation and dispensing; Domain3, medication administration; Domain4, medical order processing.

TABLE 2 The rate of SR-NUMB(*N* = 7,873)

Variables	Categories	SR-NUMB(%)	Non-SR-NUMB(%)
Domains	medication monitoring	4,180 (53.09)	3,693 (46.91)
	medication preservation and dispensing	3,733 (47.42)	4,140 (52.58)
	medication administration	5,732 (72.81)	2,141 (27.19)
	medical orders processing	3,506 (44.53)	4,367 (55.47)
Regions	Eastern	797 (80.02)	199 (19.98)
	South	760 (85.68)	127 (14.32)
	Central	2,298 (83.05)	469 (16.95)
	North	556 (74.13)	194 (25.87)
	Northwest	1,138 (80.42)	277 (19.58)
	Southwest	384 (84.96)	68 (15.04)
	Northeast	404 (66.67)	202 (33.33)

TABLE 3 Generalized linear mixed model of factors influencing SR-NUMB

Factors	Parameter estimate	Standard error	*t*	*p*	95%*CI*
Intercept	40.49	9.23	4.39	<.001	22.40, 58.57
Gender					
Male vs. female	2.62	0.86	3.05	.002	0.93, 4.31
Hospital levels					
Secondary vs. tertiary	1.04	0.339	3.08	.002	0.38, 1.71
Unit nature					
General vs. specialized	1.88	0.47	3.98	<.001	0.95, 2.81
Professional position					
Supervisor vs. nurse	1.69	0.55	3.06	.002	0.61, 2.77
Associate professor vs. nurse	4.31	0.92	4.71	<.001	2.51, 6.10
Supervisor vs. senior	1.28	0.40	3.19	.001	0.49, 2.06
Associate professor vs. senior	3.90	0.82	4.73	<.001	2.28, 5.51
Associate professor vs. supervisor	2.62	0.73	3.61	.001	1.20, 4.04
Duty					
Nursing supervisor vs. none	5.42	0.49	11.06	<.001	4.46, 6.38
Head nurse vs. none	6.98	1.31	5.31	<.001	4.40, 9.56
Director of nursing vs. none	5.44	2.55	2.13	.033	0.43, 10.44
Working years					
5–10 years vs. 15–20 years	1.58	0.61	2.61	.009	0.40, 2.77
Departments					
Common ward vs. operating room	2.80	1.14	2.47	.014	0.57, 5.02
Emergency and intensive critical units vs. operating room	3.18	1.16	2.74	.006	0.91, 5.46
Others vs. operating room	2.98	1.23	2.43	.015	0.57, 5.39
Regions	2.51	1.55	1.62	.105	0.75, 8.42

interruption during medication administration and work fatigue (especially for night shift) (Karttunen, Sneck, Jokelainen, & Elo, 2020; Wondmieneh, Alemu, Tadele, & Demis, 2020). Our results also showed that more than half of the nurses (50.83%) failed to give the medicine all the way to the patients' mouths for oral administration. Oral administration is the most common route of medication administration in hospitals. However, previous studies indicated that medication compliance for inpatients is suboptimal, especially for those with mental illness and chronic diseases (Abdisa et al., 2020; Zheng et al., 2019). In addition, drug toxicity, difficulties in swallowing and drug adverse effects should be taken into consideration when dealing with more delicate oral medicines (Boras et al., 2015; Tahaineh & Wazaify, 2017). For patients' safety, it is necessary to ensure that patients take oral medicine correctly with an accurate dosage.

Our findings showed that male nurses may have higher level of SR-NUMB than female nurses, which is similar to a previous study. Higher rate of medication errors among male nurses were identified (Cappadona et al., 2020). It might be due to the gender differences; i.e., females may be more attentive, careful and orderly than males, meanwhile, males being more honest and reporting the behaviours. It also might be due to nurses of different genders worked in the varied departments. In the present study, more than two-thirds of the male nurses worked in emergency or intensive critical units where there were only 22.16% of their female counterparts. Heavier workloads and frequent emergent events might explain the higher level of unsafe medication behaviour (Isaacs et al., 2020). However, previous studies have showed that there were no significant differences in unsafe medication behaviour between male and female nurses (Yu, Li, Gao, Liu, & Lin, 2018); thus, gender discrepancy found in the current results might be attribute to the small sample size.

Our findings indicated that nurses in secondary hospitals seem to have higher levels of SR-NUMB than those in tertiary hospitals. This outcome may be due to inherent disparities among hospitals of varying scales, including the composition of nursing human resources, nursing safety management plan, management policies, and management quality between tertiary and secondary hospitals. Based on previous research, most of the nurses in tertiary hospitals graduated with bachelor's degrees, while the nurses in secondary hospitals are mainly college and secondary school graduates (Zhang, Li, Shan, Zhang, & Zhang, 2011). Similar to the study by Lee (2017), nurses in tertiary hospitals have higher education levels than those in mid-size hospitals. In addition, the nursing management quality of tertiary hospitals may be better than that of secondary hospitals (Li, Huang, Cheng, Tong, & Mo, 2019; Zhou et al., 2018). Moreover, Nwasor, Sule, and Mshelia (2014) a questionnaire-based study found that secondary and tertiary government hospitals may have more self-reported medication errors than that of private hospitals, although no significance was identified; this result is consistent with our study, that is, nurses working at tertiary or secondary hospitals had a higher level of SR-NUMB than that of private hospitals. Although the SR-NUMB in community hospitals was at a high level (36.89 [26.00–47.41]) compared to other hospital levels, no significant difference was found. First, this may be due to limited community nurses (0.29%) participated in this study. Second, there was a large internal disparity among the participants collected from each community. One of the previous studies also revealed that there was wide variation in the rate of medication errors among participants from varied communities (Assiri et al., 2018).

Our findings also demonstrated that nurses in specialized hospitals may have a lower level of SR-NUMB than those from general hospitals. The reason might be that nurses in specialized hospitals focus on one specific type of disease. Strengthened and accumulated medication experience enables them to manage medication correctly and accurately in a proficient way (Conn, Kearney, Tully, Shields, & Dornan, 2019).

As for professional position, surprisingly, nurses or senior nurses may have lower level of SR-NUMB than supervisor nurses or associate professors of nursing. In addition, supervisor nurses may have lower level of SR-NUMB than associate professors of nursing. These outcomes are consistent with a previous finding, which showed that nurses with higher professional position are more likely to have unsafe medication behaviour (Yu, Lin, Lyu, Gao, & Liu, 2018). Inertial thinking or a mental mindset caused by experience, as well as external interference caused by administrative duties among nurses with higher professional position were potential reasons for unsafe medication behaviour. However, no significant difference in SR-NUMB was found between professors of nursing and nurses in other positions. This finding might be due to that small sample size of nurse professors was included (0.66%) and they have less clinical practice for this group.

Regarding duty type and working years for nurses, nursing supervisors, head nurses or directors of nursing who take up administrative duty may have higher level of SR-NUMB than those with clinical duty shifts in the present study. In addition, nurses who have worked for 5 to 10 years may have higher level of SR-NUMB than those who have worked for 15 to 20 years. The reason might be that nurses with longer work years have been exposed to more medication administrations and they were less susceptible to SR-NUMB (Nwasor et al., 2014). Additionally, newly graduated nurses (worked for less than 1 year) may have higher level of SR-NUMB than those who have worked for 1–5 years (Yu, Lin, Lyu, Gao, & Liu, 2018). This outcome may be due to lack of safety awareness and experience in medication management (Murray, Sundin, & Cope, 2019).

In the present study, nurses in the operating room may have a lower level of SR-NUMB than those in other medical departments. The medication administration is less complicated in this department than in other medical departments. Meanwhile, nurses in operating room had much less medication practice and medication interruption events. Furthermore, working stress is also one of the risk factors for nursing errors (Daigle, Talbot, & French, 2018). A study showed that nurses in operating rooms may have more stress than those in intensive care units (Salem & Ebrahem, 2018). It was contrasted with our results that emergency and intensive critical units may have higher level of SR-NUMB than operating rooms. Therefore, further studies on the relationship between nurse stress levels and SR-NUMB are required.

Based on our findings, there is a high percentage of nurses who had SR-NUMB in China, and the associated factors have been identified. Therefore, tailored medication safety education or training courses according to specific nurse characteristics (i.e., gender, professional position, duty, and working years) should be developed and implemented.

4.1 | Strengths and limitations

This study has two major strengths. First, this study investigated SR-NUMB that might lead to medication errors. It further explored specific causes of errors in the clinical scenarios. SR-NUMB was explored to make it much easier to find out the direct reasons for medication errors. Second, large sample size from 31 provinces in China made it possible to get knowledge of the specific status of SR-NUMB from a nationwide perspective. The present study was not without limitations. First, we used the convenience sampling method to collect the data that may cause the selection bias. Second, the self-reported questionnaire may result in the gap between the actual and reported level of NUMB. Finally, we only explored the influence of demographic variables on SR-NUMB. Other underlying factors, such as work environment, medication safety awareness and workload, should be explored in the further studies.

5 | CONCLUSION AND IMPLICATIONS

In conclusion, suboptimal status of SR-NUMB in China was identified in our study. Significant differences in SR-NUMB were tested among seven regions. The highest percentage of SR-NUMB was identified in the southern, southwest and central regions. Specifically, highest percentage of unsafe practices in medication administration domain were confirmed, followed by medication monitoring, medication preservation and dispensing, as well as medical order processing. Male nurses and nurses working in a secondary hospital or general hospital, those have higher professional positions or have only administrative duties, those have been working for 5–10 years, and those who are working in emergency and intensive critical units were more likely to have higher level of SR-NUMB. Tailored strategies for safe medication training should be developed incorporating with nurse characteristics, region discrepancies, and hospital levels. As it might improve the management efficiency and reduce additional waste of resources. Our findings may provide guidance for the further tailored interventions nurse medication practice management to improve the quality of nursing care and patient safety.

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DATA AVAILABILITY STATEMENT

Contact the authors whenever the data is required.

ORCID

Ning Qin https://orcid.org/0000-0002-3573-3066

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