Comparative Analysis of Hypertension Influencing Factors Among Nursing Staff by Gender in Hebei Province: A Postprint Based on Propensity Score Matching

Authors: Hao Xiaoran, Zhao Bin, Cui Wei, Li Jing, Liu Jie, Feng Di, Zhang Luqi, Li Yun, Li Xian, Ding Junqin, Li Laiyou, Li Lanfeng, Yin Xiaohua, Li Yuzhuo, Huang Xianghe

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Abstract

Background Due to the special nature of their work, nursing staff experience prolonged high mental stress, which can easily lead to elevated daily blood pressure. Moreover, significant differences exist between males and females in regulating blood pressure homeostasis at the tissue, cellular, and molecular levels, suggesting that hypertension influencing factors may differ between genders. Investigating these factors among nursing staff of different genders is of reference significance for developing targeted prevention and control strategies. Objective To investigate the prevalence of hypertension and conduct a comparative analysis of influencing factors among nursing staff of different genders in Hebei Province, providing a basis for formulating personalized prevention and control measures. Methods This study employed a census method to survey the current status of hypertension and related influencing factors among nursing staff in all hospitals across 11 prefecture-level cities in Hebei Province from November 2016 to July 2018. Multivariate Logistic stepwise forward regression was used to analyze hypertension influencing factors separately for male and female nursing staff. Propensity score matching was performed for recognized hypertension influencing factors between male and female nursing staff. Logistic regression models for hypertension influencing factors among nursing staff of different genders were constructed based on the matched data. The common and distinct influencing factors of hypertension between the two groups were identified by combining comparative results before and after matching. Results The prevalence rates of hypertension among male and female nursing staff in Hebei Province were 20.36% and 6.26%, respectively, with a statistically significant difference (P<0.001). “Age” , “BMI” , “duration of hyperlipidemia” ,

and "family history of hypertension" were common influencing factors for both genders, while "department" and "female-specific conditions (menstrual status, history of gestational hypertension)" were influencing factors only for female nursing staff. Conclusion The prevalence of hypertension is higher among male nursing staff than among females, with differing influencing factors between genders. Pediatric and medical technology departments only affect the risk of hypertension among females, and relevant departments may adopt targeted prevention and control measures. Additionally, female nursing staff with irregular menstruation, menopause, or a history of gestational hypertension should pay close attention to their blood pressure status, actively implement preventive measures, and minimize the risk of developing hypertension.

Full Text

Comparative Analysis of Hypertension Prevalence and Influencing Factors Among Male and Female Nurses in Hebei Province: Based on Propensity Score Matching

HAO Xiaoran[1], ZHAO Bin[2]*, CUI Wei[3], LI Jing[1], LIU Jie[1], FENG Di[1], ZHANG Luqi[1], LI Yun[1], LI Xian[4], DING Junqin[5], LI Laiyou[6], LI Lanfeng[7], YIN Xiaohua[8], LI Yuzhuo[9], HUANG Xianghe[10]

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[1] Nursing Department, The Second Hospital of Hebei Medical University, Shijiazhuang 050000, China
[2] Department of Research, The Second Hospital of Hebei Medical University, Shijiazhuang 050000, China
[3] Department of Cardiology, The Second Hospital of Hebei Medical University, Shijiazhuang 050000, China
[4] Nursing Department, Hebei General Hospital, Shijiazhuang 050051, China
[5] Nursing Department, The Third Hospital of Hebei Medical University, Shijiazhuang 050051, China
[6] Nursing Department, The Fourth Hospital of Hebei Medical University, Shijiazhuang 050000, China
[7] Nursing Department, Children' s Hospital of Hebei Province, Shijiazhuang 050031, China
[8] Nursing Department, Hebei Province Hospital of Traditional Chinese Medicine, Shijiazhuang 050011, China
[9] Nursing Department, Hebei Chest Hospital, Shijiazhuang 050041, China
[10] Nursing Department, Stomatological Hospital of Hebei Medical University, Shijiazhuang 050017, China

Corresponding author: ZHAO Bin, Director of Research Department, Chief Superintendent Nurse, Master Supervisor; E-mail: zhbgny@sina.com

Abstract

Background: Due to the demanding nature of nursing work, nurses experience chronic high mental stress, which can lead to elevated daily blood pressure. Moreover, significant physiological differences between males and females in blood pressure regulation at the tissue, cellular, and molecular levels suggest that hypertension risk factors may differ by gender. Investigating these gender-specific factors is essential for developing targeted prevention and control strategies.

Objective: To investigate the prevalence of hypertension and compare its influencing factors between male and female nurses in Hebei Province, providing evidence for personalized prevention and control measures.

Methods: This cross-sectional study employed a census method to survey all hospital nurses across 11 prefecture-level cities in Hebei Province from November 2016 to July 2018. Multivariate logistic stepwise forward regression was used to analyze hypertension influencing factors separately for male and female nurses. Recognized hypertension risk factors were then matched between genders using propensity score matching (PSM). Logistic regression models were constructed based on the matched data to identify common and distinct influencing factors.

Results: The hypertension prevalence rates were 20.36% among male nurses and 6.26% among female nurses ($P<0.001$). Age, BMI, years of hyperlipidemia, and family history of hypertension were common risk factors for both genders. Department affiliation and female-specific conditions (menstrual status, history of gestational hypertension) were risk factors exclusive to female nurses.

Conclusion: Male nurses had significantly higher hypertension prevalence than female nurses, with distinct risk factor profiles. Pediatric and medical-technical departments affected hypertension risk only in female nurses, warranting targeted interventions. Additionally, female nurses with irregular menstruation, menopause, or a history of gestational hypertension require special attention to blood pressure monitoring and preventive measures to minimize hypertension risk.

Keywords: Different gender; Nurses; Hypertension; Influencing factors; Propensity score matching

Introduction

Hypertension is a common cardiovascular disease in China. Over 90% of hypertension cases are chronic diseases resulting from interactions between genetic predisposition and multiple environmental factors, with chronic mental stress being a recognized risk factor. Due to emergency responses and shift work,

nurses frequently experience high mental stress, making hypertension prevention crucial in this population. Research indicates gender differences in hypertension pathogenesis, with distinct physiological structures leading to significant differences in blood pressure homeostasis regulation between sexes at the tissue, cellular, and molecular levels. Studies have also shown gender differences in hypertension risk factors in general populations. While most research has focused on gender differences in general populations or exclusively on female nurses, few studies have examined male nurses or gender-specific differences among nursing staff. This study aims to investigate hypertension prevalence and compare influencing factors between male and female nurses in Hebei Province to inform targeted prevention strategies.

1. Methods

1.1 Study Population This cross-sectional study employed a census method to survey nurses from 512 hospitals across 11 prefecture-level cities in Hebei Province (Shijiazhuang [including Xinji], Baoding [including Dingzhou], Cangzhou, Chengde, Handan, Hengshui, Langfang, Qinhuangdao, Tangshan, Xingtai, and Zhangjiakou) from November 2016 to July 2018. A total of 143,769 questionnaires were distributed, with 128,009 valid responses (89.04% response rate).

Inclusion criteria: (1) Registered nurses with $ $1 year of nursing experience currently working in clinical positions; (2) Age $ $18 years; (3) Clear consciousness without psychiatric disorders; (4) Informed consent and voluntary participation.

Exclusion criteria: Nurses on sick leave, maternity leave, or external training.

This study was approved by the Ethics Committee of a tertiary Grade A hospital in Hebei Province (Approval No.: 2016225), and all participants provided informed consent.

1.2 Data Collection

1.2.1 Blood Pressure Measurement Blood pressure was measured using upper-arm medical electronic sphygmomanometers certified by international standard protocols or mercury sphygmomanometers meeting metrological standards, all regularly calibrated by each department. Standard cuffs (22-26 cm long, 12 cm wide) were used, with large cuffs for obese individuals (arm circumference >32 cm) to ensure the bladder encircled at least 80% of the upper arm. Participants rested seated for at least 5 minutes before measurement, with no smoking, coffee, or tea consumption within 30 minutes and an empty bladder. Measurements were taken on the right arm at heart level in a seated position. Three consecutive readings were taken at 1-2 minute intervals, with the average of the second and third readings recorded (the first reading was discarded). Department heads supervised the process to ensure measurement consistency.

1.2.2 Questionnaire Survey A questionnaire was administered covering: (1) General information (gender, age, height, weight, hospital grade [per Hospital Grading Management Standards], location, department, education, marital status); (2) Medical history (years of hyperlipidemia, diabetes, hypertension); (3) Antihypertensive medication use; (4) Family history of hypertension; (5) Lifestyle factors (smoking, alcohol consumption, exercise); (6) Monthly night shift frequency in the past six months; (7) Female-specific conditions (menstrual status, history of gestational hypertension, oral contraceptive use, hormone replacement therapy). All data were collected online via Wenjuanxing (a survey platform).

1.3 Diagnostic Criteria and Definitions

1.3.1 Hypertension Diagnostic Criteria Hypertension was diagnosed according to the *2018 Chinese Guidelines for Prevention and Treatment of Hypertension*: systolic blood pressure (SBP) $ $140 mmHg and/or diastolic blood pressure (DBP) $ $90 mmHg without antihypertensive medication. Isolated systolic hypertension was defined as SBP $ $140 mmHg with DBP <90 mmHg. Participants with a history of hypertension currently taking antihypertensive medication were diagnosed as hypertensive regardless of blood pressure values.

1.3.3 Variable Definitions

1. **Body Mass Index (BMI):** <18.5 kg/m^2 (underweight), 18.5-<24.0 kg/m^2 (normal), 24.0-<28.0 kg/m^2 (overweight), $ 28.0$kg/m\^{}{2}$ (obese).
2. **Disease duration:** Recorded in years; conditions lasting <1 year were counted as 1 year.
3. **Family history of hypertension:** At least one parent with hypertension.
4. **Smoking:** "None" = no smoking in the past year.
5. **Alcohol consumption:** "None" = no alcohol in the past year; "Occasional" = <1 time/month; "Frequent" = $ $1 time/month.
6. **Exercise:** Physical activity outside work (e.g., running, walking) lasting $ $30 minutes; "Occasional" = 1-2 times/week; "Frequent" = $ $3 times/week.
7. **Gestational hypertension disorders:** Including gestational hypertension, preeclampsia, and eclampsia (blood pressure $ $140/90 mmHg first appearing during pregnancy and normalizing within 12 weeks postpartum, with proteinuria ranging from negative to ++, with or without convulsions).

1.4 Quality Control A hierarchical management system was established involving provincial and municipal nursing quality control centers and hospital nursing departments, with unified training for supervisors. Investigators dis-

tributed survey notifications through the provincial nursing quality control center, providing training on blood pressure measurement and questionnaire completion. Required fields were set in Wenjuanxing, and surveys were conducted regionally in batches. Data were automatically uploaded upon submission and reviewed daily by investigators, with feedback provided to municipal centers to ensure timely completion. Abnormal values were verified and corrected through follow-up. After data collection, comprehensive checks for completeness and logical consistency were performed.

1.5 Statistical Analysis Data were analyzed using SPSS 21.0 and E-Share software 2.0. Non-normally distributed continuous variables were expressed as median (interquartile range) [M(QR)] and compared using rank-sum tests. Categorical variables were expressed as rates or proportions and compared using ^{2} or rank-sum tests. Multivariate logistic stepwise forward regression was performed separately for male and female nurses, with hypertension as the dependent variable. Male models included 14 independent variables (age, BMI, education, marital status, hospital grade, location, department, night shift frequency, hyperlipidemia duration, diabetes duration, family history, smoking, alcohol consumption, exercise). Female models included these 14 variables plus 4 female-specific factors (menstrual status, gestational hypertension history, oral contraceptive use, hormone replacement therapy) for a total of 18 variables.

To address gender imbalances and baseline differences, sensitivity analysis was conducted using propensity score matching (PSM) in E-Share software with a 1:3 matching ratio and caliper value of 0.00006. Matching factors included statistically significant variables from univariate analysis that are recognized hypertension risk factors in the 2018 Chinese Hypertension Guidelines: age, BMI, hyperlipidemia, diabetes, family history of hypertension, alcohol consumption, and exercise (BMI as continuous, others as categorical). Post-matching logistic regression was repeated to identify gender-specific factors. Factors significant in both pre- and post-matching analyses were considered common risk factors; factors significant in only one gender in both analyses were considered gender-specific. $P<0.05$ was considered statistically significant.

2. Results

2.1 General Characteristics and Hypertension Prevalence Male nurses had a median age of 29 (7) years, height of 174 (8) cm, weight of 74 (15) kg, and BMI of 24.48 (4.80) kg/m^2. Female nurses had a median age of 30 (8) years, height of 161 (5) cm, weight of 58 (12) kg, and BMI of 22.11 (4.26) kg/m^2. All general characteristics differed significantly between genders ($P<0.05$). The overall hypertension prevalence among Hebei nurses was 6.86%, with significantly higher rates in males than females ($P<0.001$). Detailed comparisons are presented in Table 1 .

2.2 Influencing Factors Analysis

2.2.1 Gender-Specific Hypertension Influencing Factors Multivariate logistic regression identified age, BMI, hospital location, hyperlipidemia duration, diabetes duration, and family history of hypertension as common factors for both genders. Education, marital status, hospital grade, department, and female-specific conditions (menstrual status, gestational hypertension history) were risk factors exclusive to female nurses. Variable assignments and multivariate analysis results are detailed in Table 2 and Table 3 .

2.2.2 Sensitivity Analysis Using Propensity Score Matching After PSM using E-Share software 2.0, no significant differences remained in matched factors between genders (all P>0.1), as shown in Table 4 . Post-matching multivariate logistic regression revealed age, BMI, hyperlipidemia duration, and family history as common factors. Department, diabetes duration, and female-specific conditions (menstrual status, gestational hypertension history) were exclusive to female nurses, while hospital location was exclusive to male nurses (Table 5).

2.2.3 Integrated Comparison Results Combining pre- and post-matching analyses, age, BMI, hyperlipidemia duration, and family history of hypertension were consistently common risk factors for both genders. Department affiliation and female-specific conditions (menstrual status, gestational hypertension history) were consistently exclusive to female nurses. Thus, age, BMI, hyperlipidemia duration, and family history affect hypertension risk in both genders, while department and female-specific conditions affect only female nurses.

3. Discussion

3.1 Hypertension Prevalence and Gender Differences The overall hypertension prevalence of 6.86% among Hebei nurses is lower than rates reported in South Africa' s Eastern Cape (52%) and in Xie Chunmei' s study (18.58%), possibly due to the younger average age and larger sample size in our study. The higher prevalence among male nurses aligns with epidemiological findings in China' s general population, potentially attributable to estrogen' s protective effects on blood pressure and androgen' s pressor effects, as well as lower health literacy in males. As more men enter the nursing profession, particularly in high-stress departments like emergency and operating rooms, hospital administrators should prioritize health literacy improvement among male nurses to reduce hypertension risk.

3.2 Influencing Factors

3.2.1 Common Risk Factors Age, BMI, hyperlipidemia duration, and family history of hypertension were confirmed as common risk factors through both primary and sensitivity analyses. Hypertension risk increased with age in both genders, consistent with general population studies, likely due to organ system

aging. While age is non-modifiable, intensified prevention of other risk factors in older nurses may attenuate age-related hypertension progression.

Overweight and obesity showed dose-dependent associations with hypertension risk, consistent with previous research. The mechanism involves insulin resistance and metabolic syndrome, with adipocyte-derived leptin contributing to hypertension pathogenesis. As a major modifiable risk factor, overweight/obesity requires primary prevention through health education, dietary control, and exercise promotion.

Hyperlipidemia increased hypertension risk, consistent with Chen Yuan' s findings. Dyslipidemia affects blood pressure through altered cell membrane lipid composition and calcium transport, endothelial dysfunction with impaired nitric oxide production, and enhanced sympathetic activity with increased angiotensin II. Regular lipid monitoring and control are essential for hypertension prevention.

Family history of hypertension conferred adjusted odds ratios of 1.234 for male and 1.196 for female nurses, consistent with Yu Chengdong' s study. Hospital administrators should identify nurses with positive family histories and guide lifestyle modifications for primary prevention.

3.2.2 Gender-Specific Department Effects Department affiliation affected hypertension risk only in female nurses. Compared with internal medicine, pediatric and medical-technical departments increased hypertension risk in female nurses. Pediatric nursing involves communication challenges with children and high parental expectations, increasing workplace violence risk. Due to physiological and psychological characteristics, female nurses are more vulnerable to workplace violence, leading to heightened psychological stress, sympathetic activation, and RAAS system activation, ultimately increasing blood pressure. Targeted interventions should focus on enhancing technical skills and empathy training for female pediatric nurses to reduce stress and prevent hypertension.

Medical-technical departments present high patient volumes, uncertainty, and rapid turnover, creating anxiety-provoking work environments. Research indicates women have higher emotional susceptibility and less effective emotion regulation strategies than men when using suppression techniques, explaining why department effects were gender-specific. Training programs to improve coping abilities in female medical-technical nurses could reduce anxiety and hypertension risk.

3.2.3 Female-Specific Risk Factors Menopause was a hypertension risk factor compared with regular menstruation, consistent with He Liu' s findings, likely due to estrogen deficiency-induced endothelial dysfunction and increased BMI. History of gestational hypertension also increased risk, consistent with Ji Chunpeng' s study, possibly due to persistent elevations in total cholesterol

and glucose years after delivery. Female nurses with menstrual irregularities, menopause, or gestational hypertension history require enhanced blood pressure monitoring, lifestyle modification, and regular screening of lipid, glucose, and BMI levels to minimize hypertension risk.

3.3 Limitations This study has several limitations. The large geographic scope and sample size precluded repeated blood pressure measurements on different days; single-day repeated measurements were used instead, which experts confirmed as reliable and standard for epidemiological surveys. While 46.4% of participants used electronic sphygmomanometers and 53.6% used mercury devices, all equipment was calibrated to ensure reliability. Self-reported height and weight may have introduced BMI measurement bias. The Wenjuanxing platform lacked time controls for survey completion, which should be addressed in future research. Additionally, PSM matching factors were limited to guideline-confirmed risk factors, potentially leaving residual confounding. Whether education, marital status, and hospital grade are truly female-specific risk factors requires further investigation. As a cross-sectional study, causality cannot be established; analytical studies are needed to explore causal relationships.

Conclusion

Male nurses in Hebei Province have substantially higher hypertension prevalence than female nurses, with distinct risk factor profiles. While age, BMI, hyperlipidemia duration, and family history affect both genders, department affiliation impacts only female nurses. Furthermore, menstrual irregularities, menopause, and gestational hypertension history are female-specific risk factors. Targeted prevention strategies addressing these gender-specific risk factors are essential for effective hypertension control in this occupational group.

Author Contributions

ZHAO Bin and CUI Wei conceived the study and designed the research protocol. HAO Xiaoran, LIU Jie, and FENG Di conducted literature review and drafted the manuscript. HAO Xiaoran, LIU Jie, FENG Di, ZHANG Luqi, and LI Yun performed statistical analysis. LI Jing, LI Xian, DING Junqin, LI Laiyou, LI Lanfeng, YIN Xiaohua, LI Yuzhuo, HUANG Xianghe, HAO Xiaoran, LIU Jie, FENG Di, and LI Yun collected data. ZHAO Bin supervised quality control and revision and takes overall responsibility for the manuscript. All authors approved the final version.

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Conflict of Interest

The authors declare no conflicts of interest.

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Note: Figure translations are in progress. See original paper for figures.