Prevalence of hypertension and its related factors among K'Ho ethnic group from 25 to 64 years old at Lien Dam Commune, Di Linh District, Lam Dong Province: a cross-sectional study

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Abstract

Introduction: Hypertension is a major global health concern and a leading cause of preventable mortality. In Vietnam, ethnic minority groups such as the K'Ho may face elevated hypertension risks due to unique cultural practices and socioeconomic disparities. However, little is known about the burden and determinants of hypertension in this population. This study aimed to determine the prevalence of hypertension and examine associated factors among the K'Ho ethnic group in Lien Dam commune, Lam Dong Province.

Methods: A cross-sectional study was conducted among K'Ho adults aged 25–64 using a multistage cluster sampling method. Data were collected through structured interviews and physical examinations. Hypertension was defined according to the 2022 Vietnam National Heart Association recommendations. Multivariable logistic regression was performed to identify factors associated with hypertension. Model diagnostics, including multicollinearity, Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and Area under the ROC curve (AUC), were used to evaluate model performance.

Results: Among 328 participants, the prevalence of hypertension was 31.7%, higher than the national average. The final multivariable model retained seven predictors, showed good model fit and discriminative performance. Significant risk factors included increasing age, overweight/obesity, high sodium intake, binge drinking, and family history of hypertension. Notably, individuals affiliated with Protestantism had significantly higher prevalence of hypertension compared to Catholics.

Conclusions: Hypertension is highly prevalent among the K'Ho ethnic minority, underscoring the need for targeted public health interventions. Prevention strategies should focus on promoting healthy lifestyles, reducing alcohol and sodium intake, encouraging weight control, and prioritizing early detection, especially among those with a family history of hypertension. The potential influence of religious affiliation on health behaviours warrants further culturally sensitive investigation.

Keywords: hypertension; K'Ho ethnic group; prevalence; related factors

1. INTRODUCTION

Hypertension is a growing global health crisis, projected to affect 1.56 billion people by 2025, and remains a leading cause of preventable mortality worldwide [1]. In Vietnam, a 2019 systematic review and meta-analysis reported a pooled hypertension prevalence of 21.1% based on ten relevant studies. When restricted to three nationwide surveys, the pooled prevalence was slightly lower, at 18.4% [2]. Hypertension contributes to approximately 91,600 deaths annually in Vietnam and is responsible for 7.2% of years of life lost due to disability, primarily through its role in increasing the risk of stroke and cardiovascular disease [3].

While well-established risk factors are widely recognized [4–8], ethnic minority populations may face additional or unique risk exposures. The K'Ho, one of Vietnam's ethnic minority groups, primarily reside in the Southern Central Highlands, including Lam Dong Province [9]. Cultural practices in this community such as frequent, prolonged festivals involving high alcohol consumption and a traditional diet that includes large amounts of pickled foods may elevate their risk for hypertension [10,11].

Despite these concerns, limited research has been conducted on hypertension prevalence and its determinants within the K'Ho population. To address this gap, the present study aimed to assess the prevalence of hypertension and identify associated risk factors among the K'Ho people living in Lien Dam Commune. A better understanding of these factors is essential for informing culturally appropriate prevention and management strategies tailored to this underserved population.

2. MATERIALS AND METHODS

2.1. Study design

A cross-sectional study was conducted from February to June 2021 in Lien Dam commune, Di Linh district, Lam Dong province, Vietnam (Fig. 1).

2.2. Study population

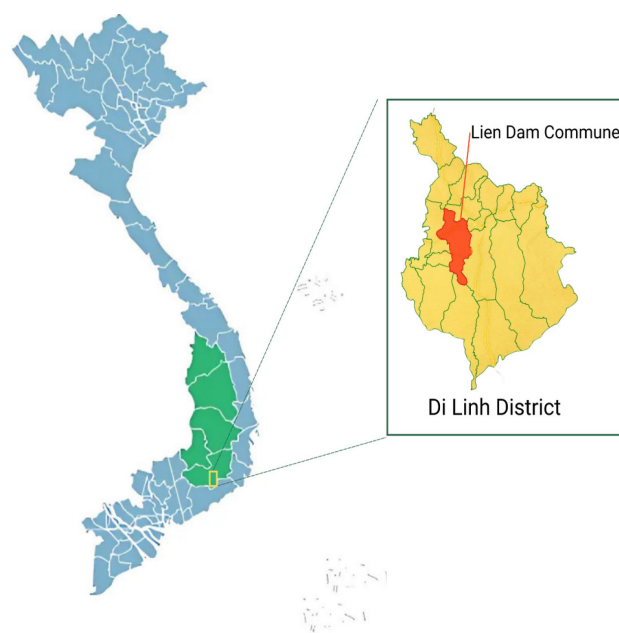K'Ho individuals aged 25 to 64 years, residing in Lien

Fig. 1. Lien Dam commune geographical map.

Dam commune during the study period, were eligible for inclusion. Individuals who were deaf, blind, severely ill, or pregnant (due to the potential for inaccurate anthropometric measurements) were excluded.

2.3. Sample size and sampling

A minimum sample size of 325 was calculated using the formula for estimating a proportion in cross-sectional studies. This calculation was based on a hypertension prevalence of 30.3% reported from a 2018 study conducted across 10 cities/provinces in Vietnam [12], a margin of error of 0.05, and a significance level (α) of 0.05.

Stratified random sampling was employed. A list of all eligible K'Ho individuals aged 25 to 64 years residing in Lien Dam commune was provided by the local authority. Then, they were stratified across five randomly selected villages. Sample sizes for each stratum were allocated proportionally (16.8%–27.2%), with 56–88 individuals per village. Within each stratum, participants were selected to achieve equal representation by sex (male, female) and by age group (25–34, 35–44, 45–54, 55–64). All eligible individuals selected from the sampling method received personal invitation and agreed to participate in the study, resulting in a final sample size of 328 (Fig. 2).

To reduce selection bias, participant recruitment followed strict inclusion and exclusion criteria. Local health workers and community leaders were actively involved in contacting and inviting eligible individuals to participate. The informed consent was obtained after a thorough explanation of the study objectives and procedures. Interviewers were rigorously trained, and quality control included detailed questionnaire design, regular data checking, and verification. Collected questionnaires were reviewed within 24 hours to ensure completeness and accuracy. If any item was missing, the interviewer would trace back the participant's ID, contact them, and confirm the information. Data for analysis, therefore, included complete questionnaires only; later data imputation was not necessary.

Data were collected via face-to-face interviews using a structured 19-item questionnaire, covering: general information (6 items), lifestyle behaviours (8 items), anthropometric and blood pressure measurements (5 items) (Supplemental Table 1). Prior to data collection, eligible participants were contacted in advance by local health workers and scheduled for a home visit at their convenient time. All interviews and measurements were conducted at the participant's homes to ensure comfort and enhance participation. Anthropometric measurements included height, weight, waist, and hip circumference. Blood pressure was measured using a Microlife® A2 Classic electronic sphygmomanometer, weight was measured using a digital scale, height was measured using a stadiometer, and waist and hip circumferences were measured using a tape measure. All measurements were taken at the start of the data collection process.

Blood pressure was measured with participants seated upright on a chair with back support, feet flat on the floor, legs uncrossed, and arms supported at heart level. The cuff was placed 2–3 cm above the elbow crease. Two readings were taken at five-minute intervals. If the difference between systolic readings exceeded 25 mmHg or diastolic readings exceeded 15 mmHg, a third measurement was taken. The average of all valid readings was used for analysis.

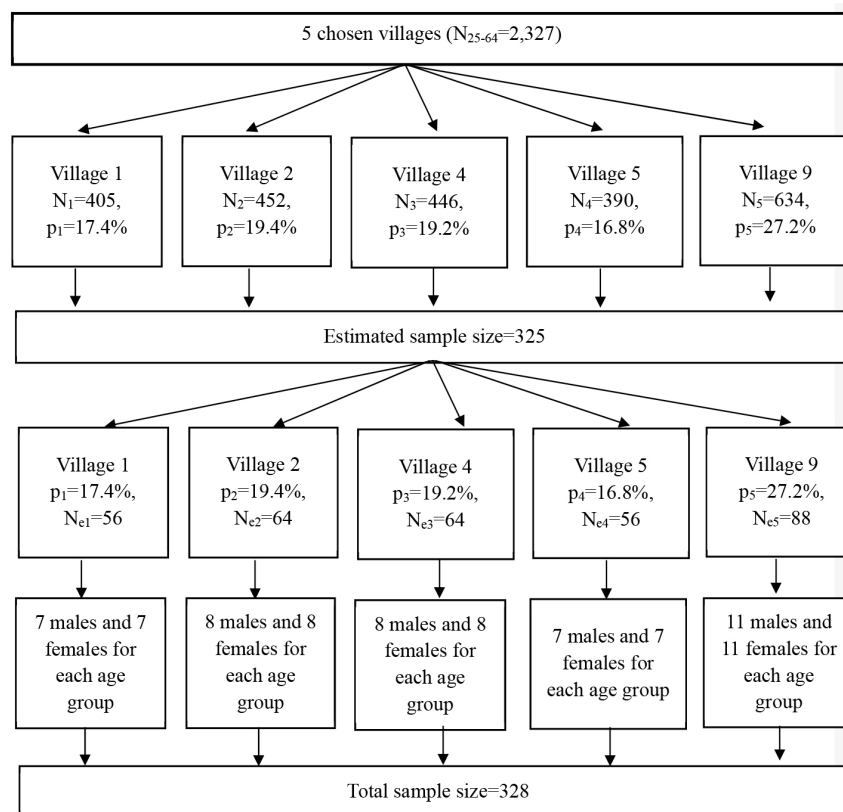The primary outcome was hypertension, defined as systolic blood pressure greater than or equal to 140 mmHg,

Fig. 2. Stratified sampling method employed in this study (n=328). N_x, actual population of village x; N_{ex}, estimated sample size of village x.

and/or diastolic blood pressure greater than or equal to 90 mmHg [13]. Body mass index (BMI) was categorized using Asia-Pacific standards of the International Diabetes Federation and the World Health Organization Western Pacific Region [14]. Waist-to-hip ratio cut-offs for high risk were greater than or equal to 0.90 for men, and greater than or equal to 0.80 for women [15]. A salty diet was defined as eating salty foods three or more days per week. Binge drinking was defined as five or more standard drinks per occasion for men, and four or more for women [16].

2.4. Statistical method

Data were entered using EpiData 3.1 and analysed using Stata 14. Descriptive statistics were used to summarize participant characteristics. Associations between hypertension and categorical variables (sex, religion, occupation, education level, BMI classification, waist-to-hip ratio classification, salty diet, alcohol consumption in the last 12 months, binge drinking, smoking in the last 12 months, history of hypertension, and parental history of hypertension) were assessed using Chi-square tests. Univariable Poisson regression was used to assess the association between hypertension and continuous variables (e.g., age). The results were presented as prevalence ratios (PR) with 95% confidence intervals. A p-value smaller than 0.05 was considered statistically significant.

Multivariable Poisson regression was used to identify independent factors associated with hypertension. All Poisson regression models (including univariable models) were fitted using a log link function. To account for potential overdispersion and violation of the equidispersion assumption, robust (sandwich) standard errors were applied. A stepwise backward elimination approach was applied: All variables with p-value smaller than 0.20 in univariable analysis were initially included. The variable with the highest p-value was removed sequentially until all remaining variables had p-values smaller than 0.05. Multicollinearity assessed via Variance Inflation Factor (VIF); VIF smaller than 5 was considered acceptable. Model comparison and model selection were guided by Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC), with lower values in-

dicating better fit. Overfitting was assessed by calculating the area under the receiver operating characteristic curve (ROC-AUC). The final model was selected based on a combination of statistical performance and interpretability.

The STROBE guidelines for cross-sectional studies were followed for reporting this study [17]. The checklist can be found in Supplemental Table 2.

3. RESULTS

The study population was distributed evenly by sex and age group. The average age of participants was 44.4±12 years. A high proportion of participants were farmers (95.1%), and Catholicism was the most prevalent religion (68.6%), followed by Protestantism (19.8%). The majority of participants had completed primary school or lower levels of education (53.9%). Most participants had a normal weight (70.7%), while 61.3% were classified as having a high-risk waist-to-hip ratio. Regarding lifestyle factors, 36.0% of participants reported consuming a salty diet. Alcohol consumption within the past 12 months was common (57.9%), whereas smoking was less prevalent (12.8%). The prevalence of binge drinking was 39.6%. A history of hypertension was reported by 17.4% of participants, and 13.1% reported a parental history of hypertension. The overall prevalence of hypertension among participants was 31.7% (Table 1).

Univariable analysis revealed that Protestantism was associated with a higher prevalence of hypertension compared to Catholicism. Individuals with occupations other than farming also had a higher proportion of hypertension than farmers. Higher educational attainment was associated with a reduction in prevalence of hypertension. Participants who were overweight or obese had a greater proportion of hypertension compared to those with normal weight. Those who reported smoking within the past 12 months had an increased prevalence of hypertension compared to non-smokers. Additionally, individuals with a parental history of hypertension were significantly more common to have hypertension than those without such a history. All these associations were statistically significant (p<0.05) (Table 2).

Multivariable Poisson regression analysis was conducted

Table 1. Participant's characteristics

Characteristic	Frequency (n)	Percentage (%)
Sex		
Male	164	50.0
Female	164	50.0
Age (year, mean±SD [Min–Max])	44.4±11.2 (25–64)	
Religion		
Catholicism	225	68.6
Protestantism	65	19.8
No/Other	38	11.6
Occupation		
Farmer	312	95.1
Other	16	4.9
Education level		
Primary school or lower	177	53.9
Secondary school	80	24.4
High school or higher	71	21.7
BMI classification		
Normal	232	70.7
Underweight	20	6.1
Overweight/obesity	76	23.2
Waist-to-hip ratio category		
Low risk	127	38.7
High risk	201	61.3
Salty diet (yes)	118	36.0
Alcohol consumption in the last 12 months (yes)	190	57.9
Binge drinking (yes)	130	39.6
Smoking in the last 12 months (yes)	42	12.8
History of hypertension (yes)	57	17.4
Parental history of hypertension (yes)	43	13.1
Hypertension (yes)	104	31.7

Min, minimum; Max, maximum.

to assess the independent associations between variables and the presence of hypertension while controlling for potential confounders. Age was significantly associated with an increased prevalence of hypertension in both crude and adjusted analyses. Specifically, each one-year increase in age was associated with a 4% higher prevalence of hypertension (adjusted PR: 1.04; 95% CI: 1.03–1.06; p<0.001). Compared to Catholicism, Protestantism remained significantly associated with a higher prevalence of hypertension (adjusted PR: 1.80; 95% CI: 1.27–2.56; p=0.001). Being overweight or obese was also significantly associated with a 1.45-fold higher prevalence of hypertension (95% CI: 1.07–1.97;

p=0.016), while underweight status was associated with a non-significant increase in hypertension in both crude and adjusted models. A salty diet was significantly associated with an increase of hypertension in the adjusted model (adjusted PR: 1.46; 95% CI: 1.10–1.95; p=0.010). Binge drinking also emerged as a strong and significant risk factor for hypertension in the adjusted model (adjusted PR: 1.69; 95% CI: 1.26–2.29; p<0.001). Parental history of hypertension remained a strong and significant predictor, with substantially increased proportion observed among individuals with a family history of hypertension (adjusted PR: 2.08; 95% CI: 1.46–2.98; p<0.001). Although occupation and smoking status were associated with a higher prevalence of hypertension in the crude model, these associations were not significant in the adjusted model (p>0.05) (Table 3).

Fig. 3 summarizes the diagnostic characteristics of the initial and final multivariable Poisson regression models. The final model included seven variables, reduced from ten in the initial model, with similar multicollinearity statistics (mean VIF=1.21, range: 1.05–1.51), indicating no significant multicollinearity (Supplemental Table 3). Model fit improved slightly, with lower AIC and BIC values in the final model. Both models demonstrated acceptable discriminative ability, with ROC-AUC values of 0.785 for the initial model and 0.779 for the final model, suggesting minimal loss of predictive performance despite variable reduction.

4. DISCUSSION

4.1. The prevalence of hypertension among study participants

The prevalence of hypertension among ethnic minority groups in Vietnam poses a significant public health concern, underscoring disparities in health outcomes across demographic populations. In this study, the prevalence of hypertension among K'Ho adults aged 25–64 was 31.7%, notably higher than the national average of 21.1% [2]. This finding aligns with previous studies reporting elevated hypertension rates among other ethnic minority groups, including the Cham (31.5%) and Khmer (33.5%) [18,19]. Similarly, research conducted in a mountainous region of Northern

Table 2. Univariable analysis of the relationship between hypertension and related factors

Characteristics	Hypertension (n [%])		p-value	PR (95% CI)
	Yes (n=104)	No (n=224)		
Sex				
Male	57 (34.8)	107 (65.2)		1
Female	47 (28.7)	117 (71.3)	0.235	0.82 (0.60–1.14)
Age (mean±SD)	48.8±0.9	42.4±0.76	<0.001[1]	1.04 (1.02–1.05)
Religion				
Catholicism	59 (26.2)	166 (73.8)		1
Protestantism	31 (47.7)	34 (52.3)	0.001	1.82 (1.30–2.55)
No/Other	14 (37.8)	23 (62.2)	0.176	1.40 (0.88–2.25)
Occupation				
Farmer	95 (30.5)	217 (69.5)		1
Other	9 (56.2)	7 (43.8)	0.031	1.36 (1.08–1.71)
Education level				
Primary school or lower	69 (39.0)	108 (61.0)		1
Secondary	21 (26.3)	59 (73.7)	0.002[2]	0.83 (0.75–0.94)
High school or higher	14 (22.5)	57 (48.5)		
BMI classification				
Normal	60 (25.9)	172 (74.1)		1
Underweight	7 (35.0)	13 (65.0)	0.375	1.35 (0.72–2.56)
Overweight/obesity	37 (48.7)	39 (51.3)	<0.001	1.88 (1.37–2.59)
Waist-to-hip ratio classification				
Low risk	40 (31.5)	87 (68.5)		1
High risk	64 (31.8)	137 (68.2)	0.948	1.01 (0.73–1.40)
Salty diet				
No	61 (29.1)	149 (70.9)		1
Yes	43 (36.4)	75 (63.6)	0.167	1.25 (0.91–1.73)
Alcohol consumption in the last 12 months				
No	43 (31.2)	95 (68.8)		1
Yes	61 (32.1)	129 (67.9)	0.856	1.03 (0.75–1.42)
Binge drinking				
No	55 (27.8)	143 (72.2)		1
Yes	49 (37.7)	81 (62.3)	0.059	1.36 (0.99–1.86)
Smoking in the last 12 months				
No	85 (29.7)	201 (70.3)		1
Yes	19 (45.2)	23 (54.8)	0.044	1.52 (1.04–2.22)
History of hypertension				
No	80 (29.52)	191 (70.48)		1
Yes	24 (42.11)	33 (57.89)	0.063	1.43 (0.99–2.04)
Parental history of hypertension				
No	82 (28.8)	203 (71.2)		1
Yes	22 (51.2)	21 (48.8)	0.003	1.78 (1.26–2.51)

Chi-square test was applied unless otherwise indicated.
[1] Univariable Poisson regression; [2] chi-square test for trend.
PR, prevalence ratio; CI, confidence interval.

Vietnam, predominantly inhabited by the Thai ethnic group, found a hypertension prevalence of 30.0% [6]. Vietnam is home to 54 ethnic groups, with the Kinh majority accounting for approximately 86% of the population [20]. Ethnic mi-

Table 3. Multivariable Poisson regression model for hypertension and related factors

Variable	Crude p-value	Crude PR (95% CI)	Adjusted p-value	Adjusted PR (95% CI)
Age	<0.001	1.04 (1.02–1.05)	<0.001	1.04 (1.03–1.06)
Religion				
Catholicism		1		1
Protestantism	0.001	1.82 (1.30–2.55)	0.001	1.80 (1.27–2.56)
No/Other	0.176	1.40 (0.88–2.25)	0.402	1.21 (0.77–1.89)
Occupation				
Farmer		1		(–)
Other	0.031	1.36 (1.08–1.71)		
Education level				
Primary school or lower		1		
Secondary	0.002	0.83 (0.75–0.94)		(–)
High school or higher				
BMI classification				
Normal		1		1
Underweight	0.375	1.35 (0.72–2.56)	0.878	1.05 (0.58–1.87)
Overweight/obesity	<0.001	1.88 (1.37–2.59)	0.016	1.45 (1.07–1.97)
Salty diet				
No		1		1
Yes	0.167	1.25 (0.91–1.73)	0.010	1.46 (1.10–1.95)
Binge drinking				
No		1		1
Yes	0.059	1.36 (0.99–1.86)	<0.001	1.69 (1.26–2.29)
Smoking in the last 12 months				
No		1		
Yes	0.044	1.52 (1.04–2.22)		(–)
History of hypertension				
No		1		
Yes	0.063	1.43 (0.99–2.04)		(–)
Parental history of hypertension				
No		1		1
Yes	0.003	1.78 (1.26–2.51)	<0.001	2.08 (1.46–2.98)

(–), variable not included in the final model.
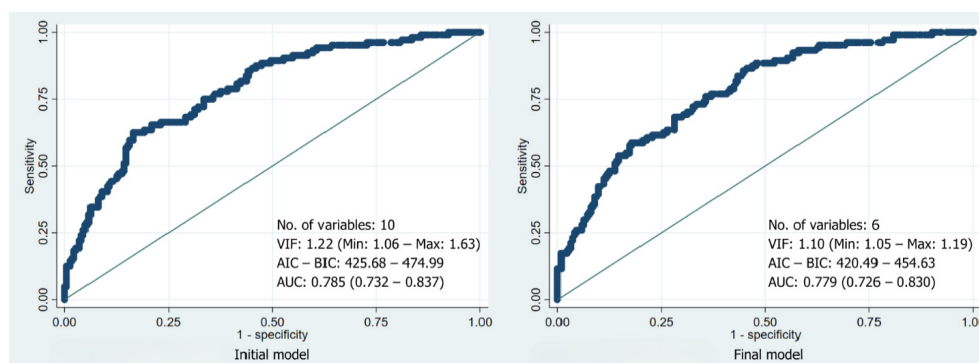PR, prevalence ratio; CI, confidence interval.

Fig. 3. Diagnostic characteristics of multivariable poisson regression models. VIF, variance inflation factors; AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; AUC, Area under the ROC curve.

nority communities, often living in remote and underserved areas, face numerous socioeconomic challenges and bear a disproportionately high burden of health issues, including hypertension [21]. Contributing factors may include limited access to healthcare services, lower levels of health literacy, and systemic inequity. In particular, community awareness of hypertension, the quality of physician–patient relationships, medication adherence, and broader health system barriers are critical issues that warrant attention [21]. Our finding highlights the urgent need for targeted public health interventions aimed at reducing the risk of hypertension in Vietnam's ethnic minority populations. Strategies should prioritize addressing socioeconomic inequality, expanding healthcare access, and enhancing health education in these communities.

4.2. Association between hypertension and related factors

The final multivariable model was selected based on a balance between model parsimony and diagnostic performance. Compared to the initial model, the final model retained fewer variables (six versus ten), reducing model complexity without compromising predictive accuracy. Multicollinearity remained minimal, with similar mean VIF values, indicating model stability and reliable estimates. Furthermore, the final model demonstrated superior fit, as evidenced by lower AIC and BIC values, while maintaining comparable discriminatory power (AUC-ROC). These metrics supported the selection of the final model for interpretation, providing an optimal balance between simplicity and explanatory capacity.

Our study confirmed the strong and consistent association between age and hypertension risk, which is consistent with prior research [22,23]. This relationship is more likely to reflect age-related physiological changes, including arterial stiffening [22]. Epidemiological data also show that systolic blood pressure tends to rise continuously with age, while diastolic pressure follows a U-shaped trajectory, peaking in midlife [24]. Socioeconomic and environmental factors, such as residence and healthcare access, may further influence this association [25]. These findings reinforce the importance of age-specific strategies for hypertension screening and management, especially among middle-aged and older adults.

A notable finding in our study was the higher risk of hypertension among Protestants compared to Catholics. This result may indirectly align with previous research in African American populations, which suggested a link between certain religious affiliations (e.g., Protestantism) and obesity—a known hypertension risk factor [26]. Our supplemental analysis supported this explanation, revealing a higher prevalence of overweight/obesity among Protestants (33.9%) than Catholics (21.4%) (PR: 1.25; 95% CI: 1.01–1.56; p=0.043). Nonetheless, the association between religion and hypertension may also reflect confounding socioeconomic or behavioural differences. While religious affiliation can promote positive health behaviours, it may also influence attitudes toward medical care [27,28]. Future research should explore the complex interplay between religion, lifestyle, and health outcomes, and inform culturally appropriate interventions.

The association between overweight/obesity and hypertension risk observed in our study aligns with a substantial body of evidence [29–31]. Numerous meta-analyses confirmed a dose-response relationship between increasing BMI and hypertension risk, underscoring its significance as a modifiable factor [32]. Our findings emphasize the urgent need for public health strategies focused on obesity prevention and weight management.

Regarding lifestyle factors among participants, high dietary sodium intake was another significant risk factor identified, consistent with prior evidence linking salt consumption to elevated blood pressure and increased cardiovascular risk [33–35]. In accordance with WHO guidelines, limiting daily sodium intake to less than 2 grams is critical for hypertension prevention and control [36]. Binge drinking was also associated with a substantially increase of hypertension in our study, with an adjusted PR of 1.72. This result is supported by extensive literature indicating a direct, dose-dependent relationship between alcohol intake and blood pressure elevation [37,38]. These findings underscore the need to integrate alcohol risk mitigation into hypertension prevention strategies and clinical guidelines.

Parental history of hypertension emerged as a strong and consistent predictor, consistent with previous studies that have identified genetic predisposition and familial aggrega-

tion as key contributors to blood pressure regulation [39,40]. This is particularly concerning in youth populations, where a family history can double the risk of early-onset hypertension [41]. Our findings highlight the importance of early identification and targeted prevention in individuals with a familial risk and underscore the value of further genetic and longitudinal research.

4.3. Limitations

While our study confirms well-established hypertension risk factors, several limitations warrant consideration. One limitation is the cross-sectional design, which restricts causal inference, precluding conclusions about the temporal sequence of our interested factors and hypertension status. Another limitation is that the study was conducted in a single commune in Vietnam, which may affect the generalizability of our findings. Our study employed cluster sampling but did not adjust the sample size to account for the design effect, which may have introduced bias or reduced the statistical power of the analysis. Even though the anthropometric measurements were taken using standardized tools and procedures, the structured questionnaire used in our study was self-developed and not adapted from any previously validated questionnaire. Although the items were built based on risk factors identified from the relevant literature, this may limit the reliability and comparability of some findings, particularly those based on self-reported behaviours. Future studies should consider using or adapting standardized and validated tools to enhance measurement accuracy and allow for cross-study comparisons. Additionally, because measurements were conducted at participants' homes at varying times of day depending on their availability, this may have introduced measurement bias, particularly for blood pressure, which is known to follow circadian rhythms. The lack of standardized timing could have affected the accuracy and comparability of measurements across participants, potentially influencing the reliability of analyses related to hypertension. The notably association between religious affiliation and hypertension also requires further exploration to elucidate underlying behavioural or psychosocial mechanisms.

5. CONCLUSION

Effective prevention and control of hypertension among the K'Ho ethnic minority requires a multidimensional approach. Public health strategies should prioritize promoting healthy dietary habits, encouraging approaches for weight management, reducing sodium intake, and limiting alcohol consumption. Early identification and intervention are particularly important for individuals with a family history of hypertension. Given the observed associations with religious affiliation, further research is warranted to explore how religious beliefs and practices may influence health behaviours and hypertension risk. Additionally, continued investigation into the genetic, environmental, and lifestyle determinants of hypertension is necessary to inform more personalized risk assessment and targeted prevention strategies.

SUPPLEMENTARY MATERIALS

Supplementary materials are only available online from: https://doi.org/10.32895/MPR.25.00013

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Conflict of interest

No potential conflict of interest relevant to this article was reported.

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Availability of data and material

Upon reasonable request, the datasets of this study can be available from the corresponding author.

Ethics approval

This study protocol was approved by the Ethics Committee in Biomedical Research of the University of Medicine and Pharmacy at Ho Chi Minh City, Viet Nam (No. 117/HDDD-DHYD, signed on February 17th, 2021).

REFERENCES

1. Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK, He J. Global burden of hypertension: analysis of worldwide data. Lancet. 2005;365(9455):217-23.

2. Meiqari L, Essink D, Wright P, Scheele F. Prevalence of hypertension in Vietnam: a systematic review and meta-analysis. Asia Pac J Public Health. 2019;31(2):101-12.

3. Nguyen TT, Hoang MV. Non-communicable diseases, food and nutrition in Vietnam from 1975 to 2015: the burden and national response. Asia Pac J Clin Nutr. 2018;27(1):19-28.

4. Khanam R, Ahmed S, Rahman S, Al Kibria GM, Syed JRR, Khan AM, et al. Prevalence and factors associated with hypertension among adults in rural Sylhet district of Bangladesh: a cross-sectional study. BMJ Open. 2019;9(10):e026722.

5. Musung JM, Kakoma PK, Mukeng CK, Tshimanga SL, Munkemena Banze JP, Kaj NK, et al. Prevalence of hypertension and associated factors in Lubumbashi city, Democratic Republic of Congo: a community-based cross-sectional study. Int J Hypertens. 2021:6674336.

6. Nam KD, Van NB, Hoang LV, Duc TP, Thi Ha TT, Tuan VT, et al. Hypertension in a mountainous province of Vietnam: prevalence and risk factors. Heliyon. 2020;6(2):e03383.

7. Ranasinghe P, Cooray DN, Jayawardena R, Katulanda P. The influence of family history of hypertension on disease prevalence and associated metabolic risk factors among Sri Lankan adults. BMC Public Health. 2015;15(1):576.

8. Van NB, Hoang LV, Van TB, Anh HNS, Minh HT, Do Nam K, et al. Prevalence and risk factors of hypertension in the Vietnamese elderly. High Blood Press Cardiovasc Prev. 2019;26(3):239-46.

9. Le MC, Mai MN. Changes in economic activities of the Co-Ho ethnic people in Lam Dong Province from Doi Moi to present. Dalat Univ Sci J. 2017;7:568-86.

10. Dan N. Central body of the Communist Party of Vietnam, Voice of the Party, Government and people of Vietnam [Internet]. K'Ho ethnic group. 2022 [cited 2019 Aug 4]. https://nhandan.vn/dan-toc-co-ho-post723902.html

11. Vietnam National Center for Social Sciences and Humanities. The K'Ho ethnic group in Vietnam. Hanoi: Social Sciences Publishing House; 2003. p. 162-5.

12. Van Minh H, Viet NL, Sinh CT, Hung PN, Ngoc NTM, Van Hung N, et al. May measurement month 2018: an analysis of blood pressure screening results from Vietnam. Eur Heart J Suppl. 2020;22(suppl_H):H139-41.

13. Vietnam National Heart Association. Recommendations of the society of hypertension - Vietnam National Heart Association (VSH/VNHA) on diagnosis and treatment of hypertension [Internet]. 2022 [cited 2024 Jun 7]. https://hntmmttn.vn/upload/attach/202291214352.pdf

14. World Health Organization. The Asia-Pacific perspective: redefining obesity and its treatment [Internet]. 2000 [cited 2024 Jun 23]. https://apps.who.int/iris/handle/10665/206936

15. Xu W, Zhang H, Paillard-Borg S, Zhu H, Qi X, Rizzuto D. Prevalence of overweight and obesity among Chinese adults: role of adiposity indicators and age. Obes Facts. 2016;9(1):17-28.

16. US National Institute on Alcohol Abuse and Alcoholism. Defining binge drinking. What colleges need to know now [Internet]. 2007 [cited 2024 Jun 23]. https://www.collegedrinkingprevention.gov/sites/cdp/files/documents/1College_Bulletin-508_361C4E.pdf

17. Strengthening the reporting of observational studies in epidemiology. STROBE checklist for cross-sectional study [Internet]. 2024 [cited 2024 Jun 23]. https://www.strobe-statement.org/download/strobe-checklist-cross-sectional-studies-pdf

18. Nguyen NH, Nguyen VT, Tran PH, Nguyen TB. The status of hypertension and some related factors in Cham ethnic minority 18 years of age or older in the South-Central region in 2017. Vietnam J Prev Med. 2021;31(6): 96-104.

19. Nguyen TB, Nguyen VT, Nguyen VC, Tran VH. Status and some factors related to hypertension in Khmer ethnic people from 25 to 64 years old in Tra Vinh province in 2015. Vietnam J Prev Med. 2015;26(13):186.

20. General Statistics Office of Vietnam. Complete results of the 2019 Viet Nam population and housing cencus [Internet]. 2020 [cited 2021 May 24]. https://www.gso.gov.vn/wp-content/uploads/2019/12/Ket-qua-toan-bo-Tong-dieu-tra-dan-so-va-nha-o-2019.pdf

21. Hien HA, Tam NM, Tam V, Derese A, Devroey D. Prevalence, awareness, treatment, and control of hypertension and its risk factors in (Central) Vietnam. Int J Hypertens. 2018;2018(1):6326984.

22. Jani B, Rajkumar C. Ageing and vascular ageing. Postgrad Med J. 2006;82(968):357-62.

23. Unger T, Borghi C, Charchar F, Khan NA, Poulter NR, Prabhakaran D, et al. 2020 International Society of Hypertension Global Hypertension Practice guidelines. Hypertension. 2020;75(6):1334-57.

24. Cheng W, Du Y, Zhang Q, Wang X, He C, He J, et al. Age-related changes in the risk of high blood pressure. Front Cardiovasc Med. 2022;9:939103.

25. Abba MS, Nduka CU, Anjorin S, Mohamed SF, Agogo E, Uthman OA. Influence of contextual socioeconomic position on hypertension risk in low- and middle-income countries: disentangling context from composition. BMC Public Health. 2021;21(1):2218.

26. Dodor B. The impact of religiosity on health behaviors and obesity among African Americans. J Hum Behav Soc Environ. 2012;22(4):451-62.

27. Rozier M. Collective action on determinants of health: a Catholic contribution. Health Prog. 2019:5-8.

28. Bernhart JA, Wilcox S, Saunders RP, Hutto B, Stucker J. Program implementation and church members' health behaviors in a countywide study of the Faith, Activity, and Nutrition Program. Prev Chronic Dis. 2021;18:E05.

29. Kim JH, Moon JS. Secular trends in pediatric overweight and obesity in Korea. J Obes Metab Syndr. 2020;29(1):12-7.

30. Kotchen TA. Obesity-related hypertension: epidemiology, pathophysiology, and clinical management. Am J Hypertens. 2010;23(11):1170-8.

31. Li Y, Teng D, Shi X, Teng X, Teng W, Shan Z, et al. Changes in the prevalence of obesity and hypertension and demographic risk factor profiles in China over 10 years: two national cross-sectional surveys. Lancet Reg Health West Pac. 2021;15:100227.

32. Tan L, Long L, Ma X, Yang W, Liao F, Peng Y, et al. As-

sociation of body mass index trajectory and hypertension risk: a systematic review of cohort studies and network meta-analysis of 89,094 participants. Front Cardiovasc Med. 2023;9:941341.

33. Youssef GS. Salt and hypertension: current views. e-J Cardiol Pract. 2022;22(3):1-10.

34. Dong OM. Excessive dietary sodium intake and elevated blood pressure: a review of current prevention and management strategies and the emerging role of pharmaconutrigenetics. BMJ Nutr Prev Health. 2018;1(1):7-16.

35. Wang YJ, Yeh TL, Shih MC, Tu YK, Chien KL. Dietary sodium intake and risk of cardiovascular disease: a systematic review and dose-response meta-analysis. Nutrients. 2020;12(10):2934.

36. World Health Organization. Salt reduction [Internet]. 2020. [cited 2021 May 24]. https://www.who.int/news-room/fact-sheets/detail/salt-reduction

37. Arora M, ElSayed A, Beger B, Naidoo P, Shilton T, Jain N, et al. The impact of alcohol consumption on cardiovascular health: myths and measures. Glob Heart. 2022;17(1):45.

38. Piano MR. Alcohol's effects on the cardiovascular system. Alcohol Res. 2017;38(2):219-41.

39. Tozawa M, Oshiro S, Iseki C, Sesoko S, Higashiuesato Y, Tana T, et al. Family history of hypertension and blood pressure in a screened cohort. Hypertens Res. 2001;24(2):93-8.

40. Strazzullo P, Galletti F, Barba G. Altered renal handling of sodium in human hypertension: short review of the evidence. Hypertension. 2003;41(5):1000-5.

41. Ewald DR, Haldeman LA. Risk factors in adolescent hypertension. Glob Pediatr Health. 2016;3:2333794X15625159.