ORIGINAL ARTICLE

Gender Variations in Hypertension Prevalence and Associated Factors in Malaysia: National Health and Morbidity Survey 2019

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ABSTRACT

INTRODUCTION: Hypertension represents a worldwide public health challenge related to chronic illnesses. This study set out to examine gender-based variations in prevalence and associated factors of hypertension in Malaysia. **MATERIALS AND METHODS:** We conducted a secondary data analysis based on the National Health and Morbidity Survey 2019, which was a nationwide cross-sectional study employing a two-stage stratified random sampling approach. Hypertension was defined as systolic BP≥ 140 or diastolic BP≥ 90 mm Hg, told to have hypertension by medical personal previously. Multiple logistic regression analysis was applied. **RESULTS:** The prevalence of hypertension among adults in Malaysia was 30.0% (95% CI: 28.57, 31.50), men 30.3% (95% CI: 28.2, 32.5), and women 29.7% (95% CI: 28.0, 31.5). For both genders, increasing age, adults with higher BMI, other Bumiputras, unemployed and those with diabetes and high cholesterol had higher odds of hypertension. Among men, alcohol consumption showed higher odds [AOR: 1.31 (95% CI: 1.02, 1.68)], meanwhile, active smokers [AOR: 0.74 (95% CI: 0.64, 0.86)] and married men [AOR: 0.74 (95% CI: 0.57, 0.94)] showed lower odds of hypertension. Among women, Chinese [AOR: 0.62 (95% CI: 0.49, 0.77)], Indian [AOR: 0.65 (95% CI: 0.49, 0.86)], and tertiary education [AOR: 0.49 (95% CI: 0.35, 0.69)] showed lower odds and physically inactive women [AOR: 1.31 (95% CI: 1.1, 1.55)] showed higher odds of hypertension. **CONCLUSION:** Prevalence and the factors associated with hypertension differ between the two genders. Intervention strategies related to hypertension should consider the gender differences particularly among young men and elderly women.

Keywords
Adult, Prevalence, Hypertension, Gender differences, Malaysia

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INTRODUCTION

Globally, hypertension stands as the top preventable risk factor for cardiovascular disease (CVD) and death from all causes. Uncontrolled hypertension contributes to stroke, heart conditions, cognitive impairment, Chronic Kidney Diseases, and renal failure.[1]

Hypertension affected 1.38 billion adults globally in 2010, representing 31.1% of the adult population.[2] It caused around 9.4 million deaths annually and was linked to 10.7 million deaths in 2015. By 2025, the global number of hypertensive individuals is expected to reach 1.56 billion.[3]

In Malaysia, cardiovascular and circulatory diseases were the main contributors to mortality in 2014 (34.8%). For both men (33.9%) and women (36.2%), cardiovascular and circulatory diseases caused the highest number of deaths and contributed to more than a third of deaths.[4] Evidence from previous research indicates that blood pressure differs between genders from early life.[5,6]

Although higher hypertension prevalence is generally tied to increased cardiovascular disease risk, this association shows gender-related differences. Both biological and behavioural factors contribute to gender differences in hypertension. Biologically, sex hormones, chromosomal variations, and other sex-related characteristics provide some protection against hypertension in women. These protective effects become evident during adolescence and continue into adulthood until menopause. Behavioural risks for hypertension include high body mass index (BMI), smoking, and physical inactivity.[7]

The associations of hypertension between men and women in Malaysia are not clear and studies between the two genders are limited. This study seeks to identify gender variations in the prevalence and associated factors of hypertension in the adult population of Malaysia.

MATERIALS AND METHODS

This study utilised data from the National Health and Morbidity Survey (NHMS) in 2019, a nationwide cross-sectional survey that employed two-stage stratified random sampling. The sampling frame was obtained from the Department of Statistics Malaysia, and further methodological details are available in the survey report.[8] Respondents provided written informed consent before being interviewed face-to-face with the aid of a tablet. Questions were adapted from the WHO STEPS questionnaire. All household members aged ≥18 years were examined for blood pressure readings. Three readings of systolic and diastolic pressure taken 15 minutes apart using Omron Digital Automatic Blood Pressure Monitor Model HEM-907, which was already validated and calibrated.[9] Blood pressures and heights and weights of respondents were measured using a standard procedure by trained nurses. Those found to have hypertension (systolic blood pressure ≥140 mmHg or diastolic blood pressure ≥90 mmHg) were informed of their condition and referred to the nearest health facility or clinic for follow-up and management.

Definitions and Dependent variables

The average of the second and third readings of systolic and diastolic pressure were used to determine the blood pressure level in the study. Respondents were classified as having hypertension if their blood pressure was ≥140 mmHg systolic or ≥90 mmHg diastolic or told to have hypertension by medical personnel previously. Hypertension status was coded as "yes=1" and "no=0".

Independent variables

Independent variables included seven socio-demographic variables and six variables related to lifestyle factors, and other Non-Communicable Diseases (NCDs). Socio-demographic variables respondents included locality, age, ethnicity, marital status, educational level, employment status and household income group. Household income was categorized into B40 (lower income group, median RM 3000), M40 (middle income group, median RM 6,275), and T20 (high-income group, median RM 13,148).[10]

Lifestyle factors comprised of smoking and alcohol drinking status, BMI, and physical activity. For smoking (adapted from the GATS questionnaire) and drinking status (adapted from AUDIT questionnaire), an individual who was currently using any smoked tobacco products and drinking alcohol was considered as "current smoker" and "current drinker". Height was measured using SECA Stadiometer 213 and weight was measured using Tanita Personal Scale HD 319. BMI was calculated by dividing weight (kg) by height in metres squared (m^2) and classified according to WHO standards: <25 kg/m^2 as underweight or normal, 25.0–29.9 kg/m^2 as overweight, and ≥30 kg/m^2 as obese. Physical activity was self-reported using the International Physical Activity Questionnaire (IPAQ) and expressed in metabolic equivalent task minutes per week (MET-minutes/week). Participants were categorised as either "active" or "inactive" based on their activity levels.

A fasting blood glucose ≥7.0 mmol/L or a previous medical diagnosis was used to define diabetes, while high cholesterol was defined as serum total cholesterol ≥6.2 mmol/L or prior diagnosis.[11,12]

Statistical analysis

Data were analysed using IBM SPSS Statistics (Version

25). The complex samples procedure was applied, with analyses conducted at the 95% confidence interval (CI). Weighting was applied to adjust for unequal sampling probabilities, non-response, and post-stratification. This was done to ensure analysis can be estimated for the population in Malaysia. Descriptive statistics was used to summarize characteristics of the study population. Complex sample descriptive analysis and Rao – Scott chi square test was used to estimate the prevalence of hypertension.

The association between hypertension status and various independent variables was examined using univariable and multivariable logistic regression. Given established evidence that blood pressure and hypertension risk differ between men and women due to biological and behavioural factors, sex-stratified logistic regression models were employed to assess whether the associations between sociodemographic, lifestyle, and other NCDs and hypertension varied by sex. This approach ensured that potential gender-specific effects were not obscured in pooled analyses and aligns with recommendations for sex-disaggregated reporting in cardiovascular research. Findings were reported as adjusted odds ratios (AOR) with 95% confidence intervals. The logit model was developed through the Backward Likelihood Ratio (LR) approach. *Confounders were selected based on theoretical considerations, clinical relevance, and evidence from previous studies.* Diagnostic testing to assess the Goodness of Fit was conducted to ensure the fit of a logistic regression model for individual cases or covariates. Potential interactions among predictors were tested to assess their scientific relevance and impact on multicollinearity. The final model incorporated all predictors and interactions that were significantly associated at the $\rho < 0.05$ level.

RESULTS

A total of 10,463 respondents aged ≥18 years were included in the study. The demographic characteristics of the survey respondents are shown in Table I. More than half of the respondents were Malays, urban dwellers, married, currently working/employed and from the lower household income group (B40 or below 40). Nearly half of them had completed secondary education. There was almost equal distribution of respondents between the two genders and age group, with the highest among the age group of ≥60 years. The mean ± SD age for this study was 40.4±16.1 years.

Table I: Sociodemographic characteristics of the respondents

Variables		Frequency (n)	Percentage (%)
Sex	Male	4782	45.7
	Female	5681	54.3
Age group (Years)	18-29	2243	21.4
	30-39	2073	19.8
	40-49	1798	17.2
	50 - 59	1896	18.1
	60 & above	2453	23.4
Locality	Urban	6376	60.9
	Rural	4087	39.1
Ethnicity	Malay	6744	64.5
	Chinese	1326	12.7
	Indian	662	6.3
	Other Bumiputras[a]	1113	10.6
	Others[b]	618	5.9
Marital status	Single	2180	20.8
	Married	7151	68.3
	Widow(er)/Divorcee	1132	10.8
Education level	No formal education	644	6.2
	Primary education	2378	22.8
	Secondary education	4961	47.7
	Tertiary education	2425	23.3
Occupation	Employed	5941	56.8
	Unemployed[c]	4514	43.2
Household Income Group (State-DOSM 2016)	B40	6694	68.2
	M40	2324	23.7
	T20	795	8.1

[a] Other Bumiputras comprising more than 40 indigenous ethnicities that reside in both Peninsular and Borneo, Malaysia
[b] Other ethnicities comprising other Malaysian minorities such as Sikh, Baba, Chitty, Eurasian, and non-citizens
[c] Unemployed includes not working and old age

The overall prevalence of hypertension (Table II) among respondents ≥18 years was 30.0% (95%CI: 28.57, 31.50). It was estimated that nearly 6.4million people in Malaysia had hypertension (data not shown). The prevalence of hypertension among men and women ≥18 years was 30.3% (95% CI: 28.22, 32.50) and 29.7% (95% CI: 27.98, 31.46) respectively. The overall mean for systolic blood pressure (SBP) was 128.01 (95% CI: 127.45, 128.56) mmHg and mean for diastolic blood pressure (DBP) was 78.46 (95% CI: 78.05, 78.87) mmHg. The mean SBP and DBP among men was 129.97 (95% CI: 129.22, 130.71) mmHg and 79.35 (95% CI: 78.82, 79.88) mmHg respectively. Meanwhile the mean SBP and DBP among women was 125.96 (95% CI: 125.20, 126.72) mmHg and 77.54 (95% CI: 77.04, 78.04) mmHg respectively.

Table II: Prevalence of hypertension among adults aged ≥ 18 years by gender in Malaysia

Variables	Male (N= 4,782)	p-value	Female (N= 5,681)	p-value
	% (95% CI)		% (95% CI)	
Overall	30.3 (28.22, 32.50)		29.7 (27.98, 31.46)	
Locality				
Urban	30.3 (27.83, 32.94)	0.987	28.1 (26.11, 30.16)	<0.001[a]
Rural	30.3 (26.87, 33.95)		35.4 (32.28, 38.73)	
Age group (years)				
18-29	11.3 (8.63, 14.74)	<0.001[a]	3.9 (2.78, 5.37)	<0.001[a]
30-39	21.5 (18.02, 25.53)		15.9 (13.34, 18.95)	
40-49	33.8 (29.09, 38.86)		35.1 (31.04, 39.36)	
50-59	49.1 (44.37, 53.79)		52.5 (48, 56.9)	
60 and above	68.6 (64.38, 72.63)		75 (71.9, 77.95)	
Ethnicity				
Malay	31.9 (29.81, 34.04)	<0.001[a]	32.6 (30.59, 34.68)	<0.001[a]
Chinese	30.2 (24.31, 36.88)		25.8 (21.6, 30.6)	
Indian	32.2 (25.25, 40.1)		29.1 (23.65, 35.17)	
Other Bumiputras	40.6 (34.59, 46.8)		34 (28.71, 39.74)	
Others	15 (9.74, 22.36)		15.5 (11.41, 20.68)	
Marital status				
Single	16.8 (13.76, 20.26)	<0.001[a]	8.4 (6.66, 10.45)	<0.001[a]
Married	36.2 (33.56, 38.95)		31.1 (28.99, 33.28)	
Widow(er)/Divorcee	60 (49.06, 69.99)		63.2 (58.28, 67.92)	
Education level				
No formal education	33.4 (23.13, 45.47)	<0.001[a]	58 (49.58, 65.98)	<0.001[a]
Primary education	38.8 (33.37, 44.51)		50.7 (46.42, 55.02)	
Secondary education	29.6 (27.17, 32.16)		29.1 (26.75, 31.52)	
Tertiary education	24.5 (20.62, 28.92)		10.7 (8.86, 12.75)	
Occupation status				
Employed	25.6 (23.45, 27.95)	<0.001[a]	19.1 (17.22, 21.17)	<0.001[a]
Unemployed	48.5 (44.42, 52.69)		38.8 (36.23, 41.43)	
Household income group (State-DOSM 2016)				
B40	30.7 (28.26, 33.16)	0.265	32.2 (29.82, 34.6)	<0.001[a]
M40	26.3 (22.78, 30.16)		22 (19.19, 25.08)	
T20	26.6 (18.09, 37.34)		19.7 (14.59, 26.12)	
BMI				
Normal BMI	21.8 (19.33, 24.54)	<0.001[a]	18.2 (15.99, 20.61)	<0.001[a]
Overweight	37.8 (34.62, 40.99)		35.9 (32.92, 38.93)	
Obesity	45.5 (40.22, 50.8)		44.2 (40.32, 48.1)	
Physical activity				
Active	28.1 (25.68, 30.62)	<0.001[a]	29 (27.04, 30.94)	0.172
Inactive	38.1 (33.79, 42.54)		31.6 (28.28, 35.07)	
Current smokers				
Non-Smokers	33.9 (30.95, 37)	<0.001[a]	29.8 (28.11, 31.59)	0.225
Current Smokers	25.6 (22.79, 28.57)		20.4 (10.02, 37.01)	
Current drinker				
Past/Non drinker	30 (28.03, 32.07)	0.618	30.5 (28.76, 32.36)	<0.001[a]
Current drinker	31.8 (25.16, 39.35)		17.3 (12.95, 22.65)	
Diabetes				
Normal	24.5 (22.39, 26.69)	<0.001[a]	22.5 (20.91, 24.19)	<0.001[a]
Diabetes	56.6 (51.64, 61.35)		61.5 (57.87, 65.09)	
Cholesterol				
Normal	20.8 (18.62, 23.22)	<0.001[a]	17.5 (15.72, 19.49)	<0.001[a]
Raised Cholesterol	50.5 (46.99, 53.95)		44.9 (41.94, 47.84)	

[a] Significant at $\alpha = 0.05$

For both genders, the prevalence of hypertension was highest among the age group ≥60 years, widower/ divorcee, lower educational group, unemployed, B40 group, Other Bumiputras, physically inactive, non-smokers and among alcoholic drinkers.

The prevalence of hypertension increased with age and BMI. Hypertension prevalence was higher among men compared to women in the 18-29 age group. However, starting at the age of ≥40 years, women had higher prevalence than men. For both genders, the population with underlying diabetes and hypercholesterolaemia had more than two times higher prevalence compared to those without comorbidities when other factors were not considered. Single men had higher prevalence compared to single women. Meanwhile, women in higher educational group, particularly women with tertiary education showed lower prevalence of hypertension.

The multivariate analyses (Table III) demonstrated that age, BMI, other Bumiputras, unemployed, current drinker, having diabetes and hypercholesterolemia had higher odds of hypertension among men. Married men and current smokers showed lower odds of hypertension. Among women, age, BMI, other Bumiputras, unemployed, physically inactive, having diabetes and hypercholesterolemia had higher odds of hypertension. Chinese and Indian women, and women with tertiary educational group had lower odds of hypertension.

In both genders, age had the highest odds of hypertension and it increased significantly with age. The highest odds were seen among the women aged ≥60 years with AOR 33.15 (95% CI: 22.35, 49.17) (ρ<0.001) compared to those aged 18-29 years. Comparing to individuals aged 18-29 years, at the age of 40 years and above, the women has about two times higher odds of hypertension compared to the males in the same age group. Similarly, the odds of having hypertension increased with increasing BMI. The odds among the overweight and obese women increased proportionately. Meanwhile, the odds to have hypertension among obese men increased nearly two times compared to overweight men.

DISCUSSION

Although high blood pressure is the leading risk factor for death globally, it is also one of the most modifiable across the life course.[13] From this study, it can be stipulated that three in ten of the Malaysian population had hypertension and the overall prevalence was similar with Indonesia (33.4%)[14] and India (30.7%)[15], but higher than Laos (20.0%)[16] and Iran (17.3%)[17]. Hypertension prevalence in this study between men and women were

Table III: Factors associated with hypertension among adults aged ≥ 18 years in Malaysia

Variables		Male				Female			
		Crude OR (95%CI)	p-value	Adjusted OR (95%CI)	p-value	Crude OR (95% CI)	p-value	Adjusted OR (95%CI)	p-value
Locality	Urban	1		1		1		1	
	Rural	1.18(1.04,1.33)	0.008*	0.99(0.84,1.15)	0.858	1.41(1.27,1.57)	<0.001*	0.97(0.83,1.14)	0.737
Age group (years)	18-29	1		1		1		1	
	30-39	2.14(1.69,2.72)	<0.001*	2.07(1.55,2.78)	<0.001*	3.59(2.64,4.88)	<0.001*	3.06(2.13,4.39)	<0.001*
	40-49	4.14(3.27,5.24)	<0.001*	4.03(2.95,5.5)	<0.001*	10.63(7.94,14.22)	<0.001*	7.37(5.13,10.58)	<0.001*
	50-59	8.11(6.46,10.19)	<0.001*	6.88(5.02,9.43)	<0.001*	24.17(18.1,32.27)	<0.001*	13.35(9.24,19.29)	<0.001*
	60 and above	16.65(13.31,20.83)	<0.001*	14.6(10.48,20.33)	<0.001*	61.18(45.73,81.84)	<0.001*	33.15(22.35,49.17)	<0.001*
Ethnicity	Malay	1		1		1		1	
	Chinese	1.34(1.13,1.6)	0.001*	0.93(0.74,1.18)	0.570	0.84(0.71,0.99)	0.041*	0.62(0.49,0.77)	<0.001*
	Indian	1.13(0.89,1.44)	0.319	0.91(0.67,1.24)	0.551	0.92(0.74,1.15)	0.455	0.65(0.49,0.86)	0.003*
	Other Bumiputras	1.27(1.05,1.54)	0.014*	1.58(1.23,2.04)	<0.001*	1.02(0.86,1.21)	0.834	1.45(1.15,1.83)	0.002*
	Others	0.43(0.33,0.57)	<0.001*	0.93(0.67,1.29)	0.648	0.56(0.43,0.73)	<0.001*	0.97(0.7,1.35)	0.868
Marital status	Single	1		1		1		1	
	Married	3.35(2.86,3.93)	<0.001*	0.74(0.57,0.94)	0.015*	4.78(3.89,5.87)	<0.001*	0.9(0.67,1.2)	0.474
	Widow(er)/ Divorcee	7.03(5.11,9.67)	<0.001*	1.15(0.76,1.75)	0.510	16.33(12.86,20.73)	<0.001*	1.23(0.88,1.73)	0.221
Education level	No formal education	1		1	0.827	1		1	
	Primary education	1.14(0.82,1.56)	0.436	1.09(0.71,1.67)	0.709	0.71(0.57,0.89)	0.003*	0.83(0.63,1.11)	0.211
	Secondary education	0.55(0.41,0.75)	<0.001*	1.03(0.67,1.58)	0.893	0.26(0.21,0.33)	<0.001*	0.77(0.58,1.03)	0.081*
	Tertiary education	0.44(0.32,0.61)	<0.001*	0.96(0.61,1.53)	0.880	0.09(0.07,0.12)	<0.001*	0.49(0.35,0.69)	<0.001*
Occupation status	Employed	1		1		1		1	
	Unemployed	2.81(2.46,3.21)	<0.001*	1.37(1.12,1.67)	0.002*	2.98(2.66,3.34)	<0.001*	1.28(1.09,1.5)	0.002*
Household income group (State- DOSM 2016)	B40	1		1	0.275	1		1	0.990
	M40	0.75(0.65,0.86)	<0.001*	0.89(0.75,1.07)	0.208	0.65(0.56,0.75)	<0.001*	0.99(0.82,1.19)	0.888
	T20	0.77(0.62,0.96)	0.019*	0.85(0.65,1.1)	0.218	0.56(0.45,0.71)	<0.001*	0.99(0.73,1.34)	0.952
BMI	Normal BMI	1		1		1		1	
	Overweight	1.82(1.59,2.08)	<0.001*	1.77(1.51,2.09)	<0.001*	2.27(1.98,2.59)	<0.001*	2.23(1.87,2.65)	<0.001*
	Obesity	2.38(2.01,2.82)	<0.001*	3.09(2.51,3.8)	<0.001*	3.03(2.63,3.49)	<0.001*	3.55(2.94,4.27)	<0.001*
Physical activity	Active							1	
	Inactive	1.52(1.33,1.75)	<0.001*	1.15(0.97,1.37)	0.113	1.23(1.09,1.39)	0.001*	1.31(1.1,1.55)	0.002*
Current smokers	Non-smokers	1		1		1		1	
	Current smokers	0.57(0.51,0.65)	<0.001*	0.74(0.64,0.86)	<0.001*	0.47(0.25,0.88)	0.019*	0.57(0.26,1.24)	0.156
Current drinker	Past/Non drinker	1		1		1		1	
	Current drinker	1.02(0.85,1.22)	0.839	1.31(1.02,1.68)	0.035*	0.53(0.39,0.72)	<0.001*	0.98(0.65,1.48)	0.930
Diabetes	Normal	1		1		1		1	
	Diabetes	3.71(3.23,4.25)	<0.001*	1.78(1.5,2.1)	<0.001*	5.06(4.45,5.76)	<0.001*	2.18(1.85,2.56)	<0.001*
Cholesterol	Normal	1		1		1		1	
	Raised Cholesterol	3.37(2.98,3.81)	<0.001*	2.03(1.75,2.36)	<0.001*	3.85(3.43,4.32)	<0.001*	1.71(1.47,1.99)	<0.001*

Backward likelihood ratio multiple logistic regression was applied. Multicollinearity and interactions were checked and not found. For men: Hosmer–Lemeshow test ϱ=0.681. Classification table (overall correctly classified percentage =75.0%) and ROC curve =81.0%) were accepted to check model fitness. For women: Hosmer–Lemeshow test ϱ=0.348. classification table (overall correctly classified percentage =77.7%) and ROC curve =85.8%) were accepted to check model fitness.
*p <0.05

equivalent. Higher prevalence was seen in men compared to women in India (men 34.2%, women 23.7%) and Iran (men 18.9%, women 15.5%) but vice versa in Indonesia (men 31.0%, women 35.4%) and Laos (18.5% among men, 21.1% among women).

The overall prevalence of hypertension in Malaysia among ≥30 years was 40.3%, higher than Korea[18] with men 34.6% and women 30.8%. Our study also showed that men have significantly higher mean SBP and DBP than women. It was similar to many studies which showed higher mean among men compared to women[15-19] and the risk of cardiovascular disease was 1.1-fold higher in women than in men for each 10mmHg increase in SBP.[20]

Age is an established independent risk factor for hypertension.[21] Our study showed high association between increasing age and hypertension. Aging reduces the elasticity of blood vessels causing arterial stiffness leading to an increase in blood pressure. It was reported in many previous studies.[22,23,24] Our study found that men had higher prevalence and odds of hypertension than women at age ≤40 years, particularly in those aged 18-29. From age 40, women showed higher prevalence and odds than men. This pattern reflects the protective role of oestrogen in women before menopause, delaying the onset of hypertension.[3,25]

Our study found that Malaysian women developed hypertension at an earlier age compared to findings from Korea, India, and the United States of America [18,26], where hypertension in women typically became more common than in men only around the age of 60. This

suggests that women in Malaysia experience a steeper rise in blood pressure starting as early as their 30s and continuing across their lifespan compared to men.[27] One study attributed this pattern to vascular resistance, linked to the balance between vasodilating and vasoconstricting adrenergic receptor tone; present in men throughout life, absent in young women, but emerging in women after menopause.[28]

Physical inactivity and overweight or obesity, both modifiable factors, are strongly linked to hypertension.[21,29] The risk of hypertension is about five times greater in obese individuals compared to those with a normal weight.[30] In our study, overweight or obese women had slightly higher odds of developing hypertension than men. Higher BMI is commonly associated with metabolic and endocrine disturbances. It is linked to greater fat mass, increased salt retention, and insulin resistance, all of which contribute to elevated blood pressure.[3,22] Sympathetic activation is also considered a key mechanism in raising blood pressure, particularly given its role in obesity and weight-related blood pressure differences between men and women.[31]

Hypertension affects differently between ethnic groups. Compared to the Malays, Other Bumiputras had higher odds of hypertension for both men and women, meanwhile the Chinese and Indian women had lower odds of hypertension. Previous studies have reported the possibility of different factors influencing the blood pressure regulations on ethnicities such as genetics and environmental factors including diets and food intake.[32,33,34] Racial differences related to hypertension between the two genders should be explored further in future studies. However, our findings were similar to a study in Singapore which showed that differences among ethnicities was partly attributed to the variability in sociodemographic characteristics of each ethnic group.[35] This finding is contrary to a study among the elderly in Malaysia which found no relation between ethnicity and hypertension.[36]

Socio economic status (SES) includes income, education level, employment type, and measures of poverty and wealth. The relationship between SES and hypertension has been inconsistent in the literature, with some studies showing higher hypertension rates in wealthier groups, while others report greater prevalence among the poor.[29] In our study, unemployment among both genders showed higher odds for hypertension, and women with tertiary education showed lower odds of getting hypertension. Research in France and Korea[18] showed that women with the highest levels of education had a lower likelihood of hypertension compared to those with the lowest levels. The studies also noted that inequalities related to education, income, and deprivation were greater in women than in men.[37] Women with low SES, especially in education, lead to the development of hypertension and were related with lower awareness, less access and contact to healthcare services and having a higher number of risk factors such as stress, poor dietary habits, poor working conditions and psychosocial exposure, less social support and health beneficial effects.[38,39,14]

An association between marital status and hypertension was also observed, with our study showing that married men had lower odds of hypertension. Single individuals may experience greater stress and lower levels of social support, while marriage could provide stability and reduce stress exposure. This supports our finding that marriage may protect men against hypertension, possibly as unmarried individuals tend to eat out more frequently and have less control over their diet.[22] Findings from Nepal showed that ever married had higher odds of hypertension for both genders.[40] Meanwhile, study in Ghana showed contrary findings with married or cohabiting women had higher odds for hypertension.[41] The study suggested that demands and stress in the marriage were the cause for hypertension among married/cohabiting women.

Evidence has indicated that cigarette smoking and drinking alcohol increases the risk of hypertension. In this study, smoking and drinking were associated with hypertension only for men. The apparent protective association for current smokers is more difficult to interpret since it contradicts extensive evidence of

smoking as a vascular stressor. One recent investigation in Saudi Arabia reported a paradoxical 22% lower risk of uncontrolled hypertension among current smokers compared to non-smokers. However, the authors cautioned that residual confounding or reverse causation may explain this counterintuitive result.[42] Another Korean epidemiological study observed an inverse relationship between current smoking and measured blood pressure after adjusting for obesity, suggesting that smokers' typically lower BMI might partly mediate the association.[43] Still, longitudinal evidence argues against a truly protective role: a Japanese cohort found that persistent smoking was associated with increased risk of incident hypertension over time (adjusted HR ~1.34), while smoking cessation attenuated this risk.[44] Thus, the cross-sectional "protective" finding in our sample is more plausibly explained by selection biases, for example, those who develop hypertension after quitting smoking, survivor bias, or underdiagnosis among long-term smokers, rather than a real protective effect.

Unlike smoking, alcohol drinking among men showed higher odds for hypertension. And it is consistent with other studies which associate current alcoholic drinking habit with hypertension.[45,46,47] Earlier studies in Malaysia found that men had a higher prevalence and greater odds of current alcohol consumption compared to women.[48,49] Infrequent or moderate alcohol intake was linked to lower systolic and diastolic blood pressure, whereas frequent consumption was associated with higher levels of both.[13] Alcohol may raise blood pressure through various mechanisms, including direct effects on the heart and vascular smooth muscle, and by stimulating the sympathetic nervous system or the renin-angiotensin-aldosterone system.

Diabetes and hyperlipidaemia are the most common comorbidities seen in individuals with hypertension. Coronary heart disease (CHD), diabetes, and arteriosclerosis become significant risks in hypertensive patients over the age of 40.[50] The presence of multiple comorbidities increases the likelihood of end-organ damage, contributing to greater morbidity and mortality. The strong link between diabetes and hypertension is believed to stem from underlying obesity, insulin resistance, and/or hyperinsulinaemia. These comorbidities appear to affect both genders similarly.

Strengths and Limitations

This study has both strengths and limitations. Its cross-sectional design limits the ability to infer causal relationships between the associated factors and hypertension. The temporal direction of associations, particularly for lifestyle-related variables such as smoking, alcohol consumption, and physical activity, cannot be determined. For example, individuals with hypertension may have modified their behaviours following diagnosis, which could lead to reverse causation. Longitudinal or prospective studies are therefore needed to establish temporality and better understand how lifestyle changes influence hypertension risk over time. Nonetheless, it is a large, population-based study that used the standard, pretested STEPS questionnaire, widely applied in other large-scale surveys, enabling comparison with similar studies.

In addition, we did not collect data on some important factors linked to hypertension, such as family history and salt intake. The absence of these data may have limited our ability to fully capture relevant risk factors. Hypertension was defined based on blood pressure measurements taken in the field rather than in a clinical setting. However, all measurements were conducted by trained nurses to maintain accuracy during data collection.

CONCLUSION

This study identified distinct gender-specific factors associated with hypertension among Malaysian adults. For both men and women, increasing age, higher BMI, being from other Bumiputra ethnicity, unemployment, and the presence of diabetes or hypercholesterolemia were associated with elevated odds of hypertension. Among women, Chinese and Indian ethnicity, as well as tertiary education, were associated with lower odds, while physical inactivity increased the odds of hypertension. Among men, current alcohol consumption was associated

with higher odds of hypertension, whereas being a current smoker or married was associated with lower odds. Although our findings suggest lower odds of hypertension among married men and current smokers, these associations should be interpreted with caution. The protective effect of marriage may be mediated by psychosocial support and healthier behaviours, whereas the inverse association with smoking likely reflects bias or confounding rather than a true physiological benefit. Longitudinal studies or causal inference methods are needed to clarify these complex relationships. The findings of this study highlight gaps in the determinants of hypertension between genders, largely influenced by biological, genetic, and environmental factors. The results underscore the need for sex-specific approaches to hypertension screening and management, particularly targeting young men and middle-aged women. Public health initiatives should address behavioural risk factors predominant among men while strengthening education, screening, and access to care for women, especially around the menopausal transition. Integrating gender considerations into prevention frameworks and clinical guidelines can promote health equity and enhance the effectiveness of hypertension and cardiovascular disease prevention efforts. Further research should examine gender-related mechanisms and guide the development of evidence-based, sex-sensitive blood pressure management strategies.

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CONFLICTS OF INTEREST

The authors have no conflicts of interest to declare.

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INSTITUTSIONAL REVIEW BOARD (ETHIC COMMITTEE)

The Medical Research and Ethics Committee (MREC), Ministry of Health Malaysia (NMRR-18-3085-44207) approved the study. Access to the NHMS 2019 dataset was granted by the Director General of Health Malaysia, and all data were anonymised prior to analysis.

REFERENCES

1. Da Y, Khan B, vathsala A. The Dual Disease Burden of Hypertension and Diabetes. Hypertens J. 2018;4:100–6.
2. Mills KT, Bundy JD, Kelly TN, Reed J, Kearney P, Reynolds K, et al. Global Disparities. Physiol Behav. 2017;176(3):139–48.
3. Rajati F, Hamzeh B, Pasdar Y, et al. Prevalence, awareness, treatment, and control of hypertension and their determinants: Results from the first cohort of non-communicable diseases in a Kurdish settlement. Sci Rep. 2019;9(1):1–10.
4. Institute for Public Health Ministry of Health Malaysia. Malaysian Burden of Disease and Injury Study 2009-2014 [Internet]. 2017. 1–240 p. Available from: http://iku.moh.gov.my/images/IKU/Document/REPORT/BOD/BOD2009-2014.pdf
5. Reckelhoff JF. Gender differences in hypertension. Curr Opin Nephrol Hypertens [Internet]. 2018;27 (3). Available from: https://journals.lww.com/co-nephrolhypertens/fulltext/2018/05000/gender_differences_in_hypertension.8.aspx
6. Di Giosia P, Giorgini P, Stamerra CA, et al. Gender Differences in Epidemiology, Pathophysiology, and Treatment of Hypertension. Curr Atheroscler Rep. 2018 Feb;20(3):13.
7. Ghosh S, Mukhopadhyay S, Barik A. Sex differences in the risk profile of hypertension: A cross-sectional study. BMJ Open. 2016;6(7):1–8.
8. Institute of Public Health Malaysia. National Health and Morbidity Survey 2015 (NHMS 2015). Vol I: Methodology and General Findings [Internet]. Vol. I, Ministry of Health Malaysia. 2015. 327 p. Available from: http://www.iku.gov.my/images/IKU/Document/nhmsreport2015vol2.pdf
9. El Assaad MA, Topouchian JA, Darné BM, Asmar RG. Validation of the Omron HEM-907 device for blood pressure measurement. Blood Press Monit. 2002;7(4):237–41.
10. Department of Statistics M. Household Income and Basic Amenities Survey 2016. 2017.

11. World Health Organization. Definition and diagnosis of diabetes mellitus and intermediate hyperglycaemia: report of a WHO/IDF consultation. Geneva; 2006.
12. Executive Summary of The Third Report of The National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation, And Treatment of High Blood Cholesterol In Adults (Adult Treatment Panel III). JAMA. 2001 May;285 (19):2486–97.
13. Attard SM, Herring AH, Zhang B, Du S, Popkin BM, Gordon-Larsen P. Attard, Smanatha A Herring, Amy H Zhang, Bing Du, Shufa Popkin, Barry M Gordon-Larsen, Penny. J Hypertens. 2015;33(5):948 –56.
14. Peltzer K, Pengpid S. The Prevalence and Social Determinants of Hypertension among Adults in Indonesia: A Cross-Sectional Population-Based National Survey. Int J Hypertens. 2018;2018.
15. Ramakrishnan S, Zachariah G, Gupta K, et al. Prevalence of hypertension among Indian adults: Results from the great India blood pressure survey. Indian Heart J. 2019;71(4):309–13.
16. Pengpid S, Vonglokham M, Kounnavong S, Sychareun V, Peltzer K. The prevalence, awareness, treatment, and control of hypertension among adults: The first crosssectional national population-based survey in laos. Vasc Health Risk Manag. 2019;15:27–33.
17. Eghbali M, Khosravi A, Feizi A, et al. Prevalence, awareness, treatment, control, and risk factors of hypertension among adults: A cross-sectional study in Iran. Epidemiol Health. 2018;(40):1–9.
18. Choi HM, Kim HC, Kang DR. Sex differences in hypertension prevalence and control: Analysis of the 2010-2014 Korea national health and nutrition examination survey. PLoS One. 2017;12(5):1–12.
19. Zhou B, Bentham J, Di Cesare M, et al. Worldwide trends in blood pressure from 1975 to 2015: a pooled analysis of 1479 population-based measurement studies with 19·1 million participants. Lancet. 2017;389(10064):37–55.
20. Wei YC, George NI, Chang CW, Hicks KA. Assessing sex differences in the risk of cardiovascular disease and mortality per increment in systolic blood pressure: A systematic review and meta-analysis of follow-up studies in the United States. PLoS One. 2017;12(1):1–15.
21. Devi P, Rao M, Sigamani A, et al. Prevalence, risk factors and awareness of hypertension in India: A systematic review. J Hum Hypertens [Internet]. 2013;27(5):281–7. Available from: http:// dx.doi.org/10.1038/jhh.2012.33
22. Soubeiga JK, Millogo T, Bicaba BW, Doulougou B, Kouanda S. Prevalence and factors associated with hypertension in Burkina Faso: A countrywide cross-sectional study. BMC Public Health [Internet]. 2017;17(1):1–8. Available from: http:// dx.doi.org/10.1186/s12889-016-3926-8
23. Del Pinto R, Ferri C. Hypertension Management at Older Age: An Update. High blood Press Cardiovasc Prev Off J Ital Soc Hypertens. 2019 Feb;26(1):27–36.
24. John O. Onuh HQ. New progress on the study of aortic stiffness in age-related hypertension. J Hypertens. 2021;38(10):1871–7.
25. Ramirez LA, Sullivan JC. Sex differences in hypertension: Where we have been and where we are going. Am J Hypertens. 2018;31(12):1247–54.
26. Fryar CD, Ostchega Y, Hales CM, Zhang G, Kruszon-Moran D. Hypertension Prevalence and Control Among Adults: United States, 2015–2016. 2015;(289):2015–6. Available from: https:// www.cdc.gov/nchs/data/databriefs/ db289_table.pdf#2.
27. Ji H, Kim A, Ebinger JE, Niiranen TJ, et al. Sex Differences in Blood Pressure Trajectories Over the Life Course. JAMA Cardiol. 2020 Mar;5(3):19–26.
28. Joyner MJ, Wallin BG, Charkoudian N. Sex differences and blood pressure regulation in humans. Exp Physiol. 2016;101(3):349–55.
29. Khanam MA, Lindeboom W, Razzaque A, et al. Undiagnosed and uncontrolled hypertension among the adults in rural Bangladesh: findings from a community-based study. J Hypertens [Internet]. 2015;33(12). Available from: https://journals.lww.com/ jhypertension/fulltext/2015/12000/undiagnosed _and_uncontrolled_hypertension_among.7.aspx

30. Raphadu TT, Staden M Van, Dibakwane WM, Monyeki KD. A Non-Invasive Investigation into the Prevalence of Higher than Normal Blood Pressure, Hypertension and the Association between Blood Pressure and Body Weight in Male and Female Adolescents in the Polokwane Local Municipality, Limpopo-South Africa: A Cros. Children. 2020;7 (3):18.
31. Sherwood A, Hill LK, Blumenthal JA, Johnson KS, Hinderliter AL. Race and sex differences in cardiovascular α-adrenergic and β-adrenergic receptor responsiveness in men andwomenwith high blood pressure. J Hypertens. 2017;35(5):975–81.
32. Naidu BM, Yusoff MFM, Abdullah S, et al. Factors associated with the severity of hypertension among Malaysian adults. PLoS One. 2019;14(1):1–16.
33. Rampal L, Rampal S, Azhar MZ, Rahman AR. Prevalence, awareness, treatment and control of hypertension in Malaysia: a national study of 16,440 subjects. Public Health. 2008 Jan;122(1):11–8.
34. Rasool AH, Rahman AR, Ismail R, et al. Ethnic differences in response to non-selective beta-blockade among racial groups in Malaysia. Int J Clin Pharmacol Ther. 2000 May;38(5):260–9.
35. Liew SJ, Lee JT, Tan CS, et al. Sociodemographic factors in relation to hypertension prevalence, awareness, treatment and control in a multi-ethnic Asian population: A cross-sectional study. BMJ Open. 2019;9(5):1–10.
36. Eshkoor SA, Hamid TA, Shahar S, Ng CK, Mun CY. Factors affecting hypertension among the malaysian elderly. J Cardiovasc Dev Dis. 2016;3(1):1-10.
37. Neufcourt L, Deguen S, Bayat S, Zins M, Grimaud O. Gender differences in the association between socioeconomic status and hypertension in France: A cross-sectional analysis of the CONSTANCES cohort. PLoS One. 2020;15(4):1–14.
38. Leng B, Jin Y, Li G, Chen L, Jin N. Socioeconomic status and hypertension: a meta-analysis. J Hypertens [Internet]. 2015;33(2). Available from: https://journals.lww.com/jhypertension/fulltext/2015/02000/socioeconomic_status_and_hypertension__a.4.aspx
39. Grotto I, Huerta M, Sharabi Y. Hypertension and socioeconomic status. Curr Opin Cardiol [Internet]. 2008;23(4). Available from: https://journals.lww.com/co-cardiology/fulltext/2008/07000/hypertension_and_socioeconomic_status.10.aspx
40. Agho KE, Osuagwu UL, Ezeh OK, Ghimire R, Chitekwe S, Ogbo FA. Gender differences in factors associated with prehypertension and hypertension in Nepal : A nationwide survey. 2018;1–18.
41. Tuoyire DA, Ayetey H. GENDER DIFFERENCES IN THE ASSOCIATION BETWEEN MARITAL STATUS AND HYPERTENSION IN GHANA. J Biosoc Sci [Internet]. 2018/05/21. 2019;51(3):313–34. Available from: https://www.cambridge.org/core/product/DA13ADDC9D42D83EC650C66CE30EA877
42. Jareebi MA. The Association Between Smoking Behavior and the Risk of Hypertension: Review of the Observational and Genetic Evidence. J Multidiscip Healthc. 2024;17:3265–81.
43. Park SE, Jang S, So WY, Kim J. Epidemiological Association of Current Smoking Status with Hypertension and Obesity among Adults Including the Elderly in Korea: Multivariate Analysis of a Nationwide Cross-Sectional Study Excluding Grades 2-3 Hypertension Cases. J Cardiovasc Dev Dis. 2024 Jul;11(7).
44. Yamato I, Kansui Y, Matsumura K, et al. Impact of smoking status on incident hypertension in a Japanese occupational population. Hypertens Res [Internet]. 2025;48(1):180–8. Available from: https://doi.org/10.1038/s41440-024-01996-x
45. Battistoni A, Canichella F, Pignatelli G, Ferrucci A, Tocci G, Volpe M. Hypertension in Young People: Epidemiology, Diagnostic Assessment and Therapeutic Approach. High Blood Press Cardiovasc Prev [Internet]. 2015;22(4):381–8. Available from: https://doi.org/10.1007/s40292-015-0114-3
46. Zatu MC, Van Rooyen JM, Kruger A, Schutte AE. Alcohol intake, hypertension development and mortality in black South Africans. Eur J Prev Cardiol. 2016;23(3):308–15.
47. Yoo MG, Park KJ, Kim HJ, et al. Association between alcohol intake and incident hypertension in

the Korean population. Alcohol [Internet]. 2019;77:19–25. Available from: https://doi.org/10.1016/j.alcohol.2018.09.002
48. Hasani WSR, Saminathan TA, Majid NLA, et al. Polysubstance use among adolescents in Malaysia: Findings from the National Health and Morbidity Survey 2017. PLoS One [Internet]. 2021;16(1 January):1–13. Available from: http://dx.doi.org/10.1371/journal.pone.0245593
49. Cheah YK. Socioeconomic Determinants Of Alcohol Consumption Among Non-Malays In Malaysia. Hitotsubashi J Econ. 2015;56(1):55–72.
50. Liu J, Ma J, Wang J, et al. Comorbidity analysis according to sex and age in hypertension patients in China. Int J Med Sci. 2016;13(2):99–107.