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Original Research

Prevalence, awareness, treatment and control of hypertension in Malaysia: A national study of 16,440 subjects

L. Rampal[a,*], S. Rampal[b], M.Z. Azhar[c], A.R. Rahman[d]

[a]*Faculty of Medicine and Health Science, Universiti Putra Malaysia Serdang, Selangor, Malaysia*
[b]*Faculty of Medicine, University of Malaya, Malaysia*
[c]*Faculty of Medicine and Health Science, Universiti Putra, Malaysia*
[d]*Cyberjaya University College of Medical Sciences, Cyberjaya, Malaysia*

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Summary *Study design:* A cross-sectional study was conducted in all states of Malaysia to determine the prevalence, awareness, treatment and control of hypertension. A stratified two-stage cluster sampling design with proportional allocation was used.
Methods: Trained nurses obtained two blood pressure measurements from each subject. Hypertension was defined as mean systolic blood pressure >140 mmHg, diastolic blood pressure >90 mmHg, or a self-reported diagnosis of hypertension and taking antihypertensive medication. All data were analysed using Stata 9.2 software and took the complex survey design into account. A two-sided *P*-value of <0.05 was considered to be statistically significant.
Results: The overall prevalence of hypertension for subjects aged $\geqslant 15$ years was 27.8% (95% confidence interval (CI) 26.9–28.8). The prevalence of hypertension was significantly higher in males (29.6%, 95% CI 28.3–31.0) compared with females (26.0%, 95% CI 25.0–27.1). Multivariate logistic regression showed that the odds of having hypertension increased with increasing age, in males, in subjects with a family history of hypertension, with increasing body mass index, in non-smokers and with decreasing levels of education. Only 34.6% of the subjects with hypertension were aware of their hypertensive status, and 32.4 were taking antihypertensive medication. Amongst the latter group, only 26.8% had their blood pressure under control. The prevalence of hypertension amongst those aged $\geqslant 30$ years has increased from 32.9% in 1996 to 40.5% in 2004.
Conclusion: In Malaysia, the prevalence of hypertension is high, but levels of awareness, treatment and control are low. There is an urgent need for a

*Corresponding author.
E-mail addresses: dr_rampal1@hotmail.com, rampal@medic.upm.edu.my (L. Rampal).

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comprehensive integrated population-based intervention programme to ameliorate the growing problem of hypertension in Malaysians.

Introduction

Cardiovascular disease (CVD) is responsible for 30% of all deaths worldwide.[1,2] It remains the most common cause of death in industrialized countries, and hypertension is the most common treatable risk factor.[3] The prevalence of hypertension has been widely reported in various regions of the world.[4,5] Hypertension is an important public health problem worldwide because of its high prevalence and its detrimental sequelae.[6,7] It is ranked third as a cause of disability-adjusted life-years and is a leading risk factor for mortality.[8] Hypertension is as prevalent in many developing countries as in the developed world.[9] By 2025, 1.56 billion people are expected to have hypertension (29% of the world's adult population).[10] Approximately 7.1 million deaths per year may be attributed to hypertension.[11] Large population-based cohort studies consistently show continuous, strong and graded relationships between blood pressure (particularly systolic pressure) and the subsequent occurrence of various atherosclerotic events.[12,13] Multiple long-term cohort studies and randomized clinical trials have shown that the risks from raised blood pressure can be partially reversed.[14,15] National surveys on prevalence, awareness, treatment and control of hypertension guide health policy makers in devising and reviewing strategies towards better control of blood pressure in the population. The aim of this study was to describe the prevalence, awareness, treatment and control of hypertension in Malaysia.

Method

Study location, study design and study population

Geographically, this study covered the whole of Malaysia, i.e. peninsular Malaysia and the states of Sabah and Sarawak in east Malaysia. This study had a population-based cross-sectional design. Malaysian residents aged $\geqslant$15 years were included in this study.

Sampling method, recruitment of subjects and data collection

Sampling was undertaken by the Statistics Department of Malaysia using a stratified two-stage cluster sampling design with proportional allocation. Each state and the Federal Territory of Kuala Lumpur constituted a primary stratum. The whole country was divided into artificially created, contiguous geographical areas called 'enumeration blocks' (EBs). An EB consisted of 80–120 living quarters (LQs) and had specified boundaries (either natural or artificial) that did not straddle administrative boundaries. Allocation of sample size for the study within the EBs was based on the number of LQs in the stratum. Approximately, eight LQs were selected from a sampled EB, with the actual number being determined by the size of the EB based on the latest listing exercise of the Statistics Department of Malaysia. In total, 8510 LQs were sampled from the selected EBs. The Ethical Committees of the Ministry of Health Malaysia and the Faculty of Medicine and Health Science, Universiti Putra Malaysia approved the study.

Data collection

The first step was for a public health worker to locate the houses included in the sample in their respective districts. When an LQ (house) included in the sample was found to be vacant, the house on the immediate right was selected instead. An appointment was arranged with the head of the selected household who was informed of the study's objectives by the public health worker. When the occupants of the sampled household were not present at the time of the initial visit, repeat visits was made either by appointment or by leaving messages with the neighbours. Visits to the LQs were then made by a trained interviewer at the appointed date. After giving their verbal consent, all respondents aged $\geqslant$15 years were interviewed by trained interviewers using a structured pre-tested questionnaire. The information given was transcribed immediately to the questionnaire.

Information on age, sex, ethnicity, smoking status, history and family history of hypertension, use of antihypertensive medications and education

status was obtained using a pre-tested standardized questionnaire. A qualified nurse measured blood pressure manually using a mercury sphygmomanometer. The study protocol procedures (including measurement of blood pressure) were reviewed with the staff and the nurses in a meeting before the study commenced. This meeting was held with the aim of preparation of fieldwork, logistic support and to reduce interobserver variability in the measurements. The instrument was also calibrated regularly. Two blood pressure measurements were obtained for all subjects in a sitting position in their respective residence. The average of these two readings was used to classify an individual.

Weight was measured using a digital bathroom scale (TANITA Model HD 309), calibrated before use. Height was measured using a SECA Body Meter Model 208. Specific quality checks were made to ensure the quality of the data collected. Body mass index (BMI) was calculated as weight in kilograms divided by the square of height in metres. The subjects were classified in terms of nutritional status based on the World Health Organization's recommendation.

A 10-day training period was conducted centrally for the interviewers. The main aims of the training programme were to develop the interviewers' interpersonal communication and interviewing skills, familiarize them with the questionnaires, motivate them, and improve team-building skills. Random checking for completeness of interviews was conducted on a daily basis.

Definitions

Hypertension

Hypertension was defined as a systolic blood pressure of $\geqslant$140 mmHg and/or a diastolic blood pressure of $\geqslant$90 mmHg on two readings, or a self-reported diagnosis of hypertension and taking antihypertensive medication.

Blood pressure control

Blood pressure control was defined as a mean blood pressure of $<$140/90 mmHg.

Statistical analysis

This study was designed to provide national estimates of the prevalence of hypertension amongst those aged $\geqslant$15 years in Malaysia. All data were analysed using Stata 9.2 software and took the complex survey design into account.[16] Post-stratification adjustment of weights was performed, taking into account the differences in sex, ethnicity and age distribution between the sample and the total Malaysian population. Categorical variables were presented as percentages with 95% CI, and any differences in proportions were tested using an adjusted Chi-squared test. Continuous variables were presented as means with 95% CI. Multiple logistic regression was used to investigate the relationship between the prevalence of hypertension and age, sex, ethnicity, family history of hypertension, education status, current smoking status and nutritional status. From the model-building process, urban status was not significant and was removed from the final model. The chunk test revealed no significant first-order interactions. A two-sided *P*-value of <0.05 was considered to be statistically significant.

Results

Characteristics of respondents by age, sex and ethnicity

Of the 8510 LQs sampled, 7927 (93.2%) were represented in this study. Table 1 shows the characteristics of the respondents by age, sex and ethnicity. Blood pressure measurements were recorded for 16,440 out of 18,805 respondents aged $\geqslant$15 years, giving a response rate of 87.4%. The majority of the respondents were Malays (56.0%), followed by Chinese (20.3%) and Indians (10.6%). Most (57.6%) of the respondents were females. The age-, sex- and ethnicity-adjusted weighted mean age of the respondents was 36.7 years (95% CI 36.3–37.1) and ranged from 15 to 100 years. There was no significant difference between the mean age of males (36.6 years) and the mean age of females (36.8 years) ($P = 0.38$).

Prevalence of hypertension by age and sex

Table 2 shows the prevalence of hypertension by age and sex. The results show that the prevalence of hypertension in respondents aged $\geqslant$15 years was 27.8% (95% CI 26.9–28.8).

The results show that the prevalence of hypertension increases with age in both sexes. For Malaysians aged 15–39 years, hypertension was significantly more prevalent in males than females ($P<0.05$). However, the prevalence of hypertension in males and females was not significantly different above the age of 40 years. Further analysis carried out to compare these results with other studies showed that the standardized

Table 1 Characteristics of respondents by age, sex and ethnicity.

Characteristics of respondents	Frequency ($n = 2219$)	Unweighted percentage	Weighted percentage*
Sex			
Male	6979	42.4	50.1
Female	9461	57.6	49.9
Total	16 440	100.0	100.0
Age group (years)			
15–19	2187	13.3	15.2
20–29	2963	18.0	24.9
30–39	3172	19.3	20.6
40–49	3196	19.4	17.5
50–59	2463	15.0	11.5
⩾60	2459	15.0	10.2
Ethnicity			
Malay	9214	56.0	53.6
Chinese	3333	20.3	27.0
Indian	1735	10.6	8.2
Others	196	1.2	0.6
Sarawak Bumiputra	675	4.1	4.6
Sabah Bumiputra	1287	7.8	6.1

*Weighted percentage—age, sex and ethnicity standardized to the Malaysian population 2004.

Table 2 Prevalence of hypertension by age and sex amongst Malaysians aged ⩾15 years.

Age (years)	Sex, % (95% CI)			*P*-value
	Men	Female	Both sexes	
Age standardized, ⩾15	29.6 (28.3–31.0)	26.0 (25.0–27.1)	27.8 (26.9–28.8)	<0.001
Age standardized, ⩾20	33.4 (31.8–34.8)	29.9 (28.7–31.1)	31.6 (30.5–32.7)	
Age standardized, ⩾30	41.5 (39.7–43.3)	39.6 (38.1–41.1)	40.5 (39.3–41.8)	
Age standardized, ⩾40	50.9 (49.0–52.9)	52.1 (50.3–53.8)	51.5 (50.1–52.9)	
15–19	9.2 (7.1–11.3)	4.1 (2.5–5.7)	6.7 (5.4–8.0)	
20–29	13.9 (11.8–16.1)	6.4 (5.1–7.7)	10.2 (8.9–11.4)	
30–39	23.4 (20.9–26.1)	16.0 (14.1–18.0)	19.7 (18.1–21.4)	
40–49	38.5 (35.6–41.4)	36.6 (34.2–39.1)	37.6 (35.6–39.5)	
50–59	56.7 (53.4–60.0)	57.3 (54.3–60.3)	57.0 (54.8–59.3)	
⩾60	66.5 (63.4–69.5)	71.8 (69.0–74.6)	69.3 (67.1–71.5)	

CI, confidence interval.

prevalence of hypertension for respondents aged ⩾30 years was 40.5% (95% CI 39.3–41.8). The overall mean systolic blood pressure was 122 mmHg (95% CI 122–122) and the overall mean diastolic blood pressure was 79 mmHg (95% CI 79–79). The mean systolic blood pressure for males (124 mmHg, 95% CI 123–124) was significantly higher than that for females (121 mmHg, 95% CI 121–122). Similarly, the mean diastolic blood pressure for males (80 mmHg, 95% CI 80–81) was significantly higher than that for females (78 mmHg, 95% CI 78–78).

Prevalence of hypertension by age and ethnicity

Table 3 shows that the prevalence of hypertension increased with age in all ethnic groups. For those respondents aged ⩾15 years, the Chinese had the highest prevalence of hypertension (30.6%), followed by the Malays (26.7%) and the Indians (25.1%). The indigenous people from the state of Sarawak 'Sarawak Bumiputra' had a higher prevalence of hypertension (31.1%) compared with the

Table 3 Prevalence of hypertension by age among the main ethnic groups aged ⩾15 years in Malaysia in 2004.

Age (years)	Ethnic groups, % (95% CI)				
	Malay	Chinese	Indians	Sarawak Bumiputra	Sabah Bumiputra
⩾15	26.7 (25.6–28.0)	30.6 (28.5–32.6)	25.1 (23.0–27.1)	31.1 (26.4–35.7)	25.6 (22.7–28.6)
Female	26.3 (25.0–27.6)	27.3 (25.0–29.7)	22.4 (19.6–25.2)	26.4 (21.0–31.8)	22.9 (19.4–26.5)
Male	27.2 (25.6–28.9)	33.7 (30.7–36.7)	27.7 (24.4–31.0)	35.7 (29.8–41.7)	28.2 (23.8–32.5)
⩾30	41.3 (39.6–42.9)	40.0 (37.4–42.5)	37.7 (34.5–41.0)	40.4 (34.7–46.1)	41.3 (37.5–45.1)
15–19	6.0 (4.5–7.6)	8.4 (4.7–12.1)	6.4 (2.5–10.3)	14.0 (5.3–22.7)	5.4 (1.5–9.4)
20–29	9.6 (8.0–11.2)	10.7 (7.6–13.8)	9.0 (5.1–12.9)	14.4 (8.8–19.9)	9.7 (6.1–13.3)
30–39	21.0 (18.9–23.2)	14.2 (11.7–17.5)	15.1 (10.4–19.7)	26.7 (19.6–33.7)	32.4 (26.7–38.1)
40–49	38.1 (35.5–40.7)	35.2 (31.3–39.2)	37.8 (32.1–43.4)	45.3 (36.2–54.3)	37.5 (31.0–44.0)
50–59	59.2 (56.4–62.1)	55.0 (50.5–59.5)	53.9 (47.2–60.6)	49.1 (38.6–59.7	58.7 (50–67.4)
⩾60	67.6 (64.6–70.5)	71.1 (67.1–75.0)	73.2 (66.8–79.6)	64.5 (55.0–74.1)	67.0 (58.7–75.3)

CI, confidence interval.

Table 4 Prevalence of awareness, treatment and control of hypertension by sex amongst Malaysians aged ⩾15 years in 2004.

	Sex, % (95% CI)			*P*-value
	Male	Female	Both sexes	
Hypertensives				
Aware	29.4 (27.4–31.5)	40.6 (38.5–42.7)	34.6 (33.1–36.2)	<0.001
Treated	27.3 (25.4–29.4)	38.1 (36.0–40.2)	32.4 (30.9–33.9)	<0.001
Controlled	7.4 (6.3–8.5)	10.0 (8.8–11.4)	8.6 (7.8–9.5)	0.001
Treated hypertensives				
Controlled	26.9 (23.4–30.7)	26.3 (23.4–29.3)	26.6 (24.2–29.0)	0.781

CI, confidence interval.

other ethnic groups. Further analysis undertaken for comparison with other studies showed that the prevalence of hypertension in those aged >30 years is very high. Malays and the indigenous people from the state of Sabah 'Sabah Bumiputra' had the highest prevalence estimates (41.3%) followed by the 'Sarawak Bumiputra' (40.4%), the Chinese (40.0%) and the Indians (37.7%). These differences in estimates were not significantly significant ($P = 0.72$).

Awareness, treatment and control of hypertension

Table 4 shows that only 34.6% (95% CI 33.1–36.2) of the study subjects with hypertension were aware that they had hypertension. Females were significantly more aware of their hypertensive status (40.6%) compared with males (29.4%), and were more likely to be on treatment and have their blood pressure under control ($P<0.01$). Among those classified as hypertensive, 32.4% (95% CI 30.9–33.9) were taking antihypertensive medication. Among those taking hypertensive medication, only 26.6% (95% CI 24.2–29.0) had a blood pressure of ⩽140/90 mmHg. Blood pressure control was only achieved in 8.6% (95% CI 7.8–9.5) of the respondents who had hypertension.

Relationship between hypertension and age, sex, family history, BMI, smoking status and education level

In the logistic regression analysis with prevalence of hypertension as the dependent variable, there was a significant crude association with age, sex, family history, BMI and education (Table 5). Using the final multivariate logistic regression model, the adjusted odds (aOR) of hypertension prevalence increased as age increased. The aOR of a male having hypertension was 70% higher than that for a female. Obese individuals (BMI ⩾30) were eight

Table 5 Relationship between hypertension and sex, family history of hypertension and body mass index.

Risk factor	Crude odds ratio (95% CI)	Adjusted odds ratio (95% CI)
Age groups (years)		
15–19	1.0	1.0
20–29	1.6 (1.2–2.0)	1.3 (1.03–1.7)
30–39	3.4 (2.7–4.3)	2.4 (1.9–3.1)
40–49	8.4 (6.6–10.6)	5.5 (4.3–7.0)
50–59	18.5 (14.7–23.2)	11.5 (9.0–14.8)
⩾60	31.4 (24.9–39.5)	22.5 (17.6–28.9)
Male	1.2 (1.1–1.29)	1.7 (1.6–2.0)
Ethnicity		
Malay	1.0	1.0
Chinese	1.2 (1.1–1.3)	1.0 (0.9–1.2)
Indian	0.9 (0.8–1.0)	0.9 (0.8–1.0)
Sarawak Bumiputra	1.2 (0.9–1.5)	1.3 (1.0–1.8)
Sabah Bumiputra	0.9 (0.8–1.1)	1.3 (1.03–1.5)
Family history of hypertension	1.6 (1.5–1.7)	1.8 (1.6–2.0)
Body mass index		
<18.5	1.0	1.0
18.5 to <25	2.6 (2.1–3.1)	2.0 (1.6–2.5)
25 to <30	6.4 (5.3–7.7)	4.5 (3.6–5.6)
⩾30	9.7 (7.9–11.9)	8.1 (6.3–10.3)
Non-smoker	1.1 (1.0–1.2)	1.3 (1.1–1.5)
Highest education attained		
⩾13 years (tertiary)	1.0	1.0
7–12 years (secondary)	1.4 (1.2–1.6)	1.3 (1.1–1.5)
1–6 years (primary)	4.8 (4.0–5.7)	1.8 (1.5–2.2)
No formal education	7.3 (6.0–8.8)	2.1 (1.7–2.7)

CI, confidence interval.

times more likely to have hypertension than individuals with a BMI <18.5 (aOR 8.1, 95% CI 6.3–10.3). Individuals with a family history of hypertension were twice as likely to have hypertension than those without a family history of hypertension (aOR 1.8, 95% CI 1.6–2.0). A non-smoker was 1.3 times more likely to have hypertension compared with a smoker (aOR 1.3, 95% CI 1.1–1.5). The prevalence of hypertension was negatively associated with different education levels. Compared with subjects with a tertiary education, the likelihood of having hypertension was highest amongst those with no formal education (aOR 2.1, 95% CI 1.7–2.7).

Discussion

CVD has been the leading cause of death in Malaysia for the last 40 years. The relationship between blood pressure and the risk of CVD events is continuous, consistent and independent of other risk factors. The higher the blood pressure, the greater the risk of heart attack, heart failure, stroke and kidney disease. The presence of additional risk factors such as smoking, diabetes and high cholesterol levels increases the CVD risk from hypertension.[17,18] In Malaysia, this is compounded by the fact that the prevalence of current smokers for Malaysians aged ⩾15 years is 44.6% for males and 2.5% for females.[19] This study provides evidence of the increasing burden of disease due to hypertension, and that current detection and treatment of hypertension is inadequate in Malaysia. The last National Health and Morbidity Survey (NHMS) in Malaysia was carried out in 1996,[20] and reported the prevalence of hypertension to be 32.9% amongst respondents aged ⩾30 years. The present study used the same methods for blood pressure measurement as the NHMS in 1996, and found that the prevalence of hypertension in the same group had risen to 40.5% in 2004.

In this study, only 34.6% of subjects with hypertension were aware of their hypertensive status, only 32.4% had ever been treated, and only 8.6% had their blood pressure under control ($<140/90$ mmHg). Comparatively, in 1996, 33% were aware of their hypertensive status, 31% had ever been treated, and only 6% had their blood pressure under control. This shows that Malaysia still has a serious problem with low awareness, low treatment and poor control of hypertension, and CVD remains the leading cause of death.

Burt et al. reported that the prevalence of hypertension in the adult US population declined progressively between 1971 and 1991, and the distributions of systolic and diastolic blood pressure have shifted downwards. Awareness, treatment and control of hypertension among the adult US population have also improved tremendously, accounting for much of the shift at the upper end of the distribution.[21] This study concurs with the NHMS in Malaysia in 1996 that women were more aware of their hypertensive status and more likely to be treated.

In this study, the prevalence of hypertension increased with age in both sexes. Interestingly, the prevalence estimates of hypertension were higher in males compared with females for those aged <50 years. For those aged $\geqslant 50$ years, the prevalence estimates of hypertension were higher among females. The effect of oestrogen on blood pressure is still controversial.[22] Endogenous oestrogen from the female gonads lowers blood pressure by stimulating endogenous vasodilators and inhibiting endogenous vasoconstrictors. However, there is evidence that exogenous oestrogen increases rather than decreases blood pressure. Post-menopausal women have lower endogenous oestrogen, which may explain the increase in the prevalence of hypertension post-menopausally. However, as for exogenous oestrogen, post-menopausal women experience a supraphysiological concentration of oestrogen in the liver. This leads to stimulation of the renin–angiotensin system via increased production of angiotensinogen in the liver. Therefore, it is not the levels of oestrogen alone that determine blood pressure levels.

The NHMS in 1996 did not report an ethnic breakdown of the prevalence of hypertension. Although the different races (Malays, Chinese and Indians) have been living in Malaysia for more than 50 years, for those respondents aged $\geqslant 30$ years, there was a difference in the estimated prevalence of hypertension between the different ethnic groups, but these differences were not statistically significant. The differences in prevalence between ethnic groups may be attributed to their genetic make-up and/or different socio-environmental factors. The current transition of diseases in Malaysia may be affecting the ethnic groups differently. The explanation is most likely to be an interaction between genetic and environmental factors. There is evidence from Malaysia to show that Malays may have increased beta adrenergic receptor sensitivity compared with Chinese and Indians.[23] There is also evidence that Malays have different genotype frequency to angiotensin receptor polymorphism than other races.[24]

The China Multicentre Study of Cardiovascular Epidemiology of 1998 reported a national prevalence of 24%.[25] While the rate of blood pressure control reported in this study showed that it had improved (from 12.7% to 19.9%), the rate remains low. Population studies on secular trends of hypertension have generally shown disappointing results. Even in the USA, there was a period of worrying trends concerning awareness, treatment and control of hypertension.[26]

The projection by Kearney et al.[27] is of concern, especially for the developing world. Hypertension is projected to pose a serious public health challenge well into 2025, with most of the socio-economic burden to be shouldered by the developing world. While global rates of blood pressure control are generally poor, the situation is worse in developing countries.[28] Although 24-h blood pressure measurements are useful to evaluate the differences between day and night and to exclude the 'white-coat' effect, this could not be carried out in this study because of practical constraints. Furthermore, most population-based studies on hypertension use a similar methodology. Information about diet and salt intake was not included in this study because of time constraints and the unavailability of a validated food frequency questionnaire.

In conclusion, the prevalence of hypertension is high in both males and females. It poses a serious problem with low awareness, low treatment and poor control. As Malaysia is a country in epidemiological transition, it faces the daunting prospect of even higher prevalence in the future. A comprehensive programme and concerted effort needs to be put into place if improvement is to be achieved.

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Ethical approval

Ethical Committees of the Ministry of Health Malaysia and the Faculty of Medicine and Health Science, Universiti Putra Malaysia.

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Competing interests

None declared.

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