ORIGINAL ARTICLE

Bali Medical Journal (*Bali MedJ)* 2022, Volume 11, Number 1: 360-367
P-ISSN.2089-1180, E-ISSN: 2302-2914

Relationship of age, body mass index (BMI), physical activity, salt intake, and stress with high blood pressure among rural dwellers in Kudat, Sabah

Khalid Mokti[1*], Syed Sharizman Syed Abdul Rahime[1]

[1]Community and Family Medicine, Faculty of Medicine and Health Sciences, Universitas Malaysia Sabah, Kinabalu, Sabah, Malaysia;

*Corresponding author:
Khalid Mokti;
Community and Family Medicine, Faculty of Medicine and Health Sciences, Universitas Malaysia Sabah, Kinabalu, Sabah, Malaysia;
khalid.mokti@ums.edu.my

Received: 2022-01-15
Accepted: 2022-04-09
Published: 2022-04-30

ABSTRACT

Background: Hypertension is one of the leading health concerns that can be intervened, especially in rural areas. Thus, this study determined the prevalence and risk factors associated with hypertension among rural dwellers in Kudat's village, Malaysia.

Methods: This study used a cross-sectional design carried out from 5th October 2019 until 17th October 2019. Universal sampling was used for sample size calculation. There are 111 respondents who are above 18 years old involved in this research. Association between hypertension and risk factors outcomes were analyzed by using logistic regression. The relationship between continuous variables was analyzed using correlation analysis.

Results: The prevalence of hypertension among Kudat's villagers was 30% (n=33). There is a significant association between age and BMI with Hypertension. Also, there is a significant correlation between age, BMI, physical activity, with blood pressure. While other risk factors, including sociodemographic and lifestyles, do not significantly correlate with hypertension.

Conclusion: Hypertension is highly prevalent in the village and is significantly associated with BMI and age group. Physical activity also correlates with blood pressure. Hence, an effective intervention that includes lifestyle and dietary behavior changes, health promotion, and health screening should be implemented to tackle this problem.

Keywords: blood pressure, hypertension, risk factors, rural population.
Cite This Article: Mokti, K., Rahime, S.S.S.A. 2022. Relationship of age, body mass index (BMI), physical activity, salt intake, and stress with high blood pressure among rural dwellers in Kudat, Sabah. *Bali Medical Journal* 11(1): 360-367. DOI: 10.15562/bmj.v11i1.3115

INTRODUCTION

Hypertension is one of the major health concerns around the world. Undiagnosed or untreated hypertension can lead to further complications. Risk factors compound the risk, such as dyslipidemia, diabetes mellitus, or smoking status. Hypertension is the most common medical condition seen in the primary healthcare setting. If not detected and treated early, it can lead to myocardial infarction, stroke, renal failure, and premature death. Some of them are irreversible and can be fatal.[1]

The World Health Organization (WHO) stated that hypertension accounted for about 40% of those aged 25 years old and above.[2] An estimated 29.8% of the world's adult population in 2010 had hypertension, which is 30.7% in men and 28.8% in women. The estimated total number of people with hypertension in 2010 was 1.33 billion; 346 million in high-income and 985 million in low and middle-income countries. From 2000 to 2010, the age-standardized prevalence of hypertension increased by 2.5%, and the number of people with hypertension increased by 354 million.[3] However, because of population growth and aging, the number of people with uncontrolled hypertension rose from 600 million in 1980 to nearly 1 billion in 2008. The prevalence of hypertension among 18 years old and above is 35.3%, as shown in the latest National Health and Morbidity Survey (NHMS) Malaysia for non-communicable risk factors in 2015, increasing from 33.6% in 2011.[3]

In Malaysia, non-communicable diseases have been the leading cause of death and the most significant contributor to disability-adjusted life years (DALY). Hypertension is the primary contributor for both genders.[4] Findings from HMS Malaysia show that hypertension cases in Malaysia were more prevalent in rural areas than urban areas. A study in Malaysia found that the overall prevalence of hypertension for subjects aged ≥15 years was 27.8%. This study shows that hypertension increased with increasing age in males, subjects with a family history of hypertension, BMI, non-smokers, and decreased education levels.[5] A study shows that chronic exposure to psychological stress could elevate blood pressure and develop hypertension.[6]

Furthermore, in Sabah, Malaysia there was 26.8% of those aged 18 years old and above were hypertensive. It shows that hypertension is one of the common non-communicable cases in Sabah. It could also be shown in the study that there is a higher prevalence of hypertension in the rural population, in which explanation of this phenomenon will be due to

rural lifestyle factors including physical inactivity, excess dietary intake of sodium, and fat.[7] Besides, urban residents may be more likely to be treated and have better access to health care with higher awareness, causing rural residents to have more severe hypertension.[8] This study aims to determine associated factors of hypertension and the relationship of the variable amongst Kudat's villagers.

METHODS

General Background of Research

This study is a cross-sectional study. This study is conducted in selected Kudat's village, Malaysia, which is Limau-limauan village. It was chosen to represent the rural area of the Kudat district. The sociodemographic was homogeneous with other villages in Kudat. It was carried out among adult villagers from 5th October 2019 to 17th October 2019. The universal sampling method was used in this study. This method is applied by including all of the eligible adult respondents. Every respondent in the village who fulfilled both inclusion and exclusion criteria will be taken as a sample. This method is done because the sample size calculated is 107 respondents. The inclusion criteria for this study were those aged 18 years old and above. Exclusion criteria include pregnant, diagnosed with secondary hypertension and those who refuse to participate in the study.

Sample of Research

If they are eligible to participate in our research, the study's purpose was explained to them before informed consent was taken from the respondents. A Malay-translated version of our questionnaires was used. For the questionnaire, a face-to-face interview was used to collect the data. Moving on to physical examination, a few steps or things are needed for the data collectors to accurately measure the blood pressure according to Malaysia Guidelines Management of Hypertension.[9]

Instrument and Procedures

A combination set of questionnaires were used to collect data for our study. It is designed using validated sources such as the International Physical Activity Questionnaire (IPAQ) and Depression, Anxiety, Stress Scale (Depression, Anxiety, Stress Scale (DASS)-21), and salt intake questionnaire. We also conducted a physical examination, measuring respondents' blood pressure, height, and weight. Mercury sphygmomanometers were used for measuring blood pressure, measuring tapes with an accuracy of 0.01 meter (m) were used for measuring height, and weighing scale (Seca 761 model) with an accuracy of 0.5 kilograms (kg) were used for measuring height. All the tools were calibrated before data collection.

Data Analysis

The entire data entry and analysis were accomplished by using SPSS version 26.0. A p-value of <0.05 at a 95% confidence interval was considered significant. Since this is a cross-sectional study, the odds ratio was calculated and used to test the association between exposure variables and hypertension. The variable was analyzed until the multivariable test using multiple logistic regression. The relationships between blood pressure and the variables were analyzed using Spearman's correlation.

Operational Definitions

Hypertension is defined as a persistent elevation of systolic blood pressure of 140mmHg or higher and/or diastolic blood pressure of 90mmHg or higher, or the participants are under medications for hypertension. Stress is defined as a DASS21 score of 15 and above. Physical activities can be defined as Metabolic Equivalent of the task (MET) scores based on the IPAQ. BMI and Dietary salt intake is defined and classified, following the Ministry of Health, Malaysia guideline.

RESULTS

The sociodemographic characteristics of participants were shown in table 1. The prevalence of hypertension in Kudat's villagers is 30% (n=33). Half of the older respondents are hypertensive compared to only 9.1% of the younger respondents.

There is a significant association between age and BMI with Hypertension. Age ≥50 (OR: 5.96 (95% CI: 2.45-14.50)) and overweight/obese (OR: 3.14 (95% CI: 1.32-7.47)) were significantly associated with hypertension in Kudat's village. The majority of the overweight and obese respondents (41.1%) are hypertensive compared to only 18.2% of the normal and underweight hypertensive respondents. Other variables analyzed in this study were not significant.

For multivariable analysis, both age>50 (aOR: 2.83 95% CI: 1.12-7.17) and Overweight/obesity (aOR: 5.58 (95% CI 2.24-13.89)) were independently significantly associated with hypertension in this study.

Based on Table 4, Age and BMI positively correlated significantly with systolic blood pressure (SBP) and diastolic blood pressure (DBP). In contrast, IPAC was negatively markedly correlated with SBP and DBP. There were no correlations between the Salt score and DASS with SBP and DBP.

DISCUSSION

Prevalence of Hypertension

According to research done in India, the overall prevalence of hypertension was 29.8%. About 33% of urban and 25% of rural Indians are hypertensive.[10] In another research conducted in China, more than one-fourth had hypertension, and the prevalence has increased significantly during recent decades.[11] According to Myanmar's research, the prevalence of hypertension was 22%, stratified as 21.5% in men and 22.7% in women.[1] Some studies have been carried out in Malaysia about the prevalence of hypertension. According to research done in 2016, it is stated that hypertension is common in Malaysian adults, which was 42.0% of the studied population.[7] NHMS 2015 recorded 30.3% of the Malaysian population over 18 years old to be hypertensive.

In Sabah, there was 26.8% of the prevalence of hypertension has been reported.[12] Also, based on the study done in 2019, the number of newly diagnosed cases of hypertension was 24.5% of 330 people in rural coastal communities in Eastern Sabah, Malaysia. With an estimated population of 551,963 in 2011, the prevalence of hypertension in Sabah was 29.1%. While in 2015, with an estimated population of 617,197, the prevalence of hypertension is 26.8%.[12] In our study area, the prevalence of hypertension is 30%, higher than the Prevalence of Sabah in

Table 1. Sociodemographic Characteristics of Kudat's Villagers.

Variables	Mean (SD[1])	Median (IQR[2])	Frequency (n)	Percent (%)
Prevalence			33	30.0
Age	41.9	40.0		
18-29			28	25.2
30-39			27	24.3
40-49			20	18.0
50-59			18	16.2
≥60			18	16.2
Gender				
Male			53	47.7
Female			58	52.3
Ethnicity				
Bajau			64	57.7
Suluk			32	28.8
Others			15	13.5
Marital Status				
Single			15	13.5
Married			84	75.7
Divorced			2	1.8
Widow/Widower			10	9.0
Highest Education				
No Schooling			12	10.8
Primary Education			43	38.7
Secondary Education			47	42.3
Higher Education			9	8.1
Occupational Status				
Employed			66	59.5
Unemployed			41	36.9
Student			1	0.9
Retiree			3	2.7
Occupation (Employed)				
Fisherman			21	31.8
Government Servant			5	7.6
Self-Employed			16	24.2
Anchovies Picker			11	16.7
Business			3	4.5
Others			10	15.2
Monthly Income				
<RM160			5	7.6
RM160-RM250			9	13.6
>RM250			52	78.8
Smoking				
Active Smoker			43	38.7
Non-Smoker			68	61.3

Variables	Mean (SD[1])	Median (IQR[2])	Frequency (n)	Percent (%)
IPAC	5758.0	3459.0		
Low (<600)			11	9.9
Moderate (600-2999)			43	38.7
High (≥3000)			57	51.4
Salt Intake	54.6	52.0		
Low (0-49)			40	36.0
Moderate (50-79)			69	62.2
High (80-100)			2	1.8
DASS	9.1	8.0		
Normal (0-14)			90	81.1
Mild (15-18)			10	9.0
Moderate (19-25)			9	8.1
Severe (26-33)			1	0.9
Extremely Severe (≥34)			1	0.9
BMI	24.2	23.0		
Underweight (<18.5)			11	9.9
Normal (18.5-22.9)			44	39.6
Overweight (23.0-27.4)			36	32.4
Obese (≥27.5)			20	18.0
SBP	123 (20.6)	121(23)		
DBP	78(15.6)	78(15)		

SD: Standard deviation, IQR: Interquartile range, IPAQ: International Physical Activity Questionnaires, DASS, BMI: Body mass index, SBP: Systolic Blood pressure DBP: Diastolic Blood Pressure

2015. According to our study, only 39.4% (13 out of 33) are diagnosed and treated with hypertension.

Association and Relationship Between Age and Hypertension

According to research done in 2016, hypertension is a highly prevalent condition that dramatically rises in incidence with increasing age.[13] NHMS has stated a general increasing trend in prevalence with age, from 6.7% in the 18-19 years age group, reaching a peak of 75.4% among the 70-74 years age group. A study in 2016 states that there is a difference in the prevalence of hypertension between different age groups, where older age records the highest prevalence.[7] Another article supports this statement, which states that older age has a significant association with hypertension.[14]

A significant association between age>50 (aOR: 2.83 95% CI: 1.12-7.17) and hypertension in bivariable and multivariable analysis. Also, in the correlation study, our study found a positive correlation between age with SBP (r=0.452, p=0.01) and DBP (r=0.294, p=0.01). The previous study in Malaysia has shown that hypertension's prevalence rises with increasing age due to stiffening of arteries during the aging process.[1,15] Other studies have also demonstrated higher plasma levels of CRP, IL-6, TNF-α, and IL-1ß in hypertensive patients than normotensive peers. Clinical and pre-clinical evidence indicates that vascular oxygen production and systemic oxidative stress are present before substantial blood pressure elevations, contributing to the transition from prehypertension to hypertension.[13]

Association and Relationship Between BMI and Hypertension

A study done in 2017 found that weight loss is inversely associated, and weight increase is positively associated with the probability of uncontrolled hypertension in obese and overweight individuals.[16] Studies support these found that the risk of hypertension was higher among population groups with overweight and obesity (BMI >25 kg/m^2).[8,17] In our study, there is a significant association between BMI and Hypertension in multivariable analysis. Also, in the correlation study, our research found a negative correlation between BMI with SBP (r=0.304, p=0.01) and DBP (r=0.191, p=0.05).

Our findings are supported by a study that shows that being overweight and obese emerged as having the most impact and correlated to more severe hypertension.[8] Another research also shows that for every 10% increment in BMI, SBP increased by 3.85 mmHg, whereas DBP increased by 1.79 mmHg.[18] Numerous studies have also suggested that the long-term effects of weight reduction could lower the likelihood of getting hypertension. Therefore, first-line therapy should consist of a lifestyle modification by increasing physical activity and following a healthy diet regimen.[19] With this, it can lower the

chances of getting more exposed to the risk of hypertension development.

Relationship Between Physical Activity and Hypertension

According to a study in 2013, modifiable risk factors such as physical activity is a significant risk factors in reducing the risk for hypertension.[20] These are proven by the study's result, which shows that those with moderate physical activities have a higher risk of having hypertension than those with high physical activities. Besides that, a study was done in 2015 also showed that physical activity level was positively associated with SBP.[21] All of these are strongly supported by a study in 2001, which states heart rate and blood pressure will be reduced as blood flow improves by increasing physical activity level.[22]

Our study shows that physical inactivity does put one at a higher risk of hypertension development. We could not establish a significant association between physical activity and hypertension in simple logistic regression analysis. However, in the correlation study, our study found a negative correlation between IPAQ with SBP (r=-0.216, p=0.05) and DBP (r=0.233, p=0.05). The increase in activity level has a weak relationship with reducing the SBP and DBP. Acutely, exercise has been associated with

Table 2. Bivariable Analysis on Associated Factor for Hypertension among Kudat's Villagers.

Variable	Hypertension			OR[1]	p value	95% CI[2]
	Total	No (n=78)	Yes (n=33)			
	N	f (%)	f (%)			
Age						
<50	75	62 (82.7)	13 (17.3)	-	-	-
≥50	36	16 (44.4)	20 (55.6)	5.96	>0.01*	2.45-14.50
Gender						
Male	53	35 (66.0)	18 (34.0)	1.47	0.35	0.65-3.34
Female	58	43 (74.1)	15 (25.9)	-	-	-
Ethnicity						
Others	47	36 (76.6)	11 (23.4)	-	-	-
Bajau	64	42 (65.6)	22 (34.4)	1.71	0.21	0.73-4.01
Marital Status						
Married	84	62 (73.8)	22 (26.2)	-	-	-
Single	27	16 ((59.3)	11 (40.7)	1.94	0.15	0.78-4.81
Education						
Non-illiterate	99	71 (71.7)	28 (28.3)	-	-	-
Illiterate	12	7 (58.3)	5 (41.7)	1.81	0.34	0.53-6.19
Employment						
Unemployed	45	33 (73.3)	12 (26.7)	-	-	-
Employed	66	45 (68.2)	21 (31.8)	1.28	0.56	0.55-2.97
Smoker						
No	68	50 (73.5)	18 (26.5)	-	-	-
Yes	43	28 (65.1)	15 (34.9)	1.49	0.35	0.65-3.40
Physical Activity						
High	57	43 (75.4)	14 (24.6)	0.68	0.20	0.07-1.77
Moderate	43	26 (60.5)	17 (39.5)	0.34	0.68	0.13-3.54
Low	11	9 (81.8)	2 (18.2)	-	-	-
Salt Intake						
Low	40	27 (67.5)	13 (32.5)	1.23	0.63	0.53-2.84
Moderate/High	71	51 (71.8)	20 (28.2)	-	-	-
Stress						
No	90	62 (68.9)	28 (31.1)	1.45	0.51	0.48-4.34
Yes	21	16 (76.2)	5 (23.8)	-	-	-
BMI						
Non-overweight	55	45 (81.8)	10 (18.2)	-	-	-
Overweight	56	33 (58.8)	23 (41.1)	3.14	0.01	1.32-7.47

[1]OR= odds ratio; [2]95% CI= 95% confidence interval

Table 3. Multivariable Analysis on Associated Factors for Hypertension among Kudat's Villagersl.

Variable	B	S. E	Wald	Crude		Adjusted	
				OR[1]	95% CI[2]	OR[1]	95% CI[2]
Age >50	1.04	0.47	4.80	5.96	2.45-14.5	2.83	1.12-7.17
Overweight/Obesity	1.72	0.47	13.63	3.14	1.32-7.47	5.58	2.24-13.89

[1]OR= odds ratio; [2]95% CI= 95% confidence interval

Table 4. Correlations between Age, IPAC, Salt Score, BMI, and DASS with SBP and DBP.

Variable	SBP	DBP
Age	0.452**	0.294**
IPAC	-0.216*	-0.233*
Salt Score	-0.040	0.005
BMI	0.304**	0.191*
DASS (stress)	-0.111	-0.050

**Significant at 0.05; ** Significant at 0.01*

immediate significant reductions in SBP. After exercise, this immediate reduction in blood pressure can persist for almost 24 hours. It is referred to as post-exercise hypotension, with the most pronounced effects seen in those with higher baseline blood pressure. The increase of exercise frequency results in more sustained blood pressure reductions, which is referred to as the exercise training response.[23]

Reduction in blood pressure with physical activity is thought to be due to attenuation in peripheral vascular resistance, probably due to neurohormonal and structural responses with reductions in sympathetic nerve activity and increased arterial lumen diameters. Other proposed mechanisms for blood pressure reduction include favorable changes in oxidative stress, inflammation, endothelial function, arterial compliance, body mass, renin-angiotensin system activity, parasympathetic activity, renal function, and insulin sensitivity. The mechanisms underlying blood pressure reduction with exercise and its associated outcomes are still under investigation, with many studies limited by size and marked heterogeneity.[24]

Oxidative stress is associated with hypertension's pathogenesis with decreased bioavailability of nitric oxide (NO) as one of the pathogenesis mechanisms. It has been suggested that physical exercise could be a potential non-pharmacological strategy in treating hypertension because of its beneficial effects on oxidative stress and endothelial function. Most previous studies found that aerobic exercise significantly decreased blood pressure and oxidative stress in hypertensive subjects.[25]

Relationship Between Dietary Salt Intake and Hypertension

A study was done to see the association between hypertension and diet; it was shown that SBP was higher in participants with those with a higher salt intake.[26] A study done in 2017 states that excessive dietary salt (sodium chloride) intake is associated with an increased risk for hypertension.[27] On the other hand, reducing dietary salt intake leads to a considerable reduction in blood pressure, especially in hypertensive patients. Another study conducted in 2017, emphasizing the association between stress and hypertension prevalence, revealed that stress increases hypertension prevalence. However, dietary evaluations' weakness is that many foods' salt content is not precisely known and information in nutrient databases is limited.[28]

Our study could not establish a significant association between dietary salt intake and hypertension that there is no significant association between dietary salt intake and hypertension. In correlation analysis, we are were unable to find the relationship between salt intake with SBP and DBP. A previous study found that not every person reacts to dietary salt intake changes with alterations in blood pressure, dividing people into salt-sensitive and insensitive groups. It is estimated that 50-60% of hypertensives are salt-sensitive. In addition to genetic polymorphisms, salt sensitivity increases in aging, black people, and persons with metabolic syndrome or obesity.

Relationship Between Stress Level and Hypertension

Stress is related to blood pressure changes, supported by studying the relationship between stress and hypertension.[29] Results of the study show a significant association between stress and hypertension. Moreover, the research in 2017 also strongly supports the statement that hypertensive patients have a higher OR of psychosocial stress than normotensive patients. SBP, DBP, and rates of hypertension were higher in the stress group than in the no-stress group, accounting for 9.1 % of the risk of hypertension.[11] This study could not establish a significant association between stress and hypertension in the bivariable analysis. Also, in the correlation study, there also no relationship between stress and SBP and DBP. It has been suggested that chronic exposure to psychological stress could cause an increase in blood pressure and lead to hypertension development.[6]

Strengths and Limitations

Our research's strengths are undoubtedly found in our validated questionnaire combination that related to hypertension; stress (DASS 21), physical activity (IPAQ), and dietary salt intake (salt intake questionnaire). Our study also analyzed both the association and relationship of the independent variable with the outcome.

The sample size for the research is small; however it reaches the minimal sample calculation requirement. Also, to analyze the association between BMI and Hypertension, the BMI was re-categorized into normal/underweight and overweight/obese due to inadequate respondents in certain categories. Besides that, we are also

fully aware of the recall bias that might interrupt the respondents' ability to recall the information extracted from them correctly.

CONCLUSION

To conclude, the villagers with higher BMI and older age groups should focus on the hypertension screening program. Hence, effective intervention should be implemented to tackle this problem. The interventions that can be done include changes in dietary and lifestyle behavior of the rural population. The consultation, proper management of hypertensive cases, health talk, and health screening with a healthcare provider. The rural dweller also should learn self-blood pressure monitoring. Therefore, the recommendation for this study is that the sample size should be larger to enable reliable results to be obtained. More than one village should be studied and chosen randomly. This indeed can increase the accuracy of the results obtained.

AUTHOR CONTRIBUTION

Khalid Mokti (KM) was responsible for literature search, data analysis, statistical analysis, manuscript preparation, editing, and review. Syed Sharizman Syed Abdul Rahim (SS) was responsible for concepts, design, the definition of intellectual content, clinical studies, data acquisition, and manuscript preparation. Both authors read and approved the final manuscript.

FUNDING

There are no funding sources, grants, or third-party support.

CONFLICT OF INTEREST

The authors declare that they do not have any conflicts of interest.

ETHICAL CONSIDERATION

This study received ethical approval (JKEtika 1/21 (22)) from Universiti Malaysia Sabah Medical Research Ethics Committee.

REFERENCES

1. Naing C, Yeoh PN, Wai VN, Win NN, Kuan LP, Aung K. Hypertension in Malaysia: An analysis of trends from the national surveys 1996 to 2011. Med (United States). 2016;95(2):1–7.
2. World Health Organization International Society of Hypertension Writing Group. 2003 World Health Organization (WHO)/ International Society of Hypertension (ISH) statement on management of hypertension. J Hypertens. 2003;21(11):1983–92. Available from: http://www.who.int/cardiovascular_diseases/guidelines/hypertension_guidelines.pdf?ua=1
3. Mills KT, Bundy JD, Kelly TN, Reed JE, Kearney PM, Reynolds K, et al. Global Burden of Hypertension. J Hypertens. 2015;33(Supplement 2):e2. Available from: http://dx.doi.org/10.1097/01.hjh.0000469726.59998.cc
4. Ahmad N, Hassan Y, Tangiisuran B, Meng OL, Aziz NA, Ahmad F-D, et al. Guidelines adherence and hypertension control at a tertiary hospital in Malaysia. J Eval Clin Pract. 2012;no-no. Available from: http://dx.doi.org/10.1111/j.1365-2753.2012.01852.x
5. Ng CR, Selvarajah L, Loh YL. AB0913 To determine the association between plaque and non plaque psoriasis with their joint manifestation in psoriatic arthritis patient – a single centre experience in malaysia [Internet]. Psoriatic arthritis. BMJ Publishing Group Ltd and European League Against Rheumatism; 2018. Available from: http://dx.doi.org/10.1136/annrheumdis-2018-eular.6493
6. Gasperin D, Netuveli G, Dias-da-Costa JS, Pattussi MP. Effect of psychological stress on blood pressure increase: a meta-analysis of cohort studies. Cad Saude Publica. 2009;25(4):715–26. Available from: http://dx.doi.org/10.1590/s0102-311x2009000400002
7. Abdul-Razak S, Daher AM, Ramli AS, Ariffin F, Mazapuspavina MY, Ambigga KS, et al. Prevalence, awareness, treatment, control and socio demographic determinants of hypertension in Malaysian adults. BMC Public Health. 2016;16:351. Available from: https://pubmed.ncbi.nlm.nih.gov/27097542
8. Mahadir Naidu B, Mohd Yusoff MF, Abdullah S, Musa KI, Yaacob NM, Mohamad MS, et al. Factors associated with the severity of hypertension among Malaysian adults. PLoS One. 2019;14(1):e0207472–e0207472. Available from: https://pubmed.ncbi.nlm.nih.gov/30605462
9. Rashid A, Khalid Y, Chia Y. Management of hypertension. Malaysian Fam physician Off J Acad Fam Physicians Malaysia. 2011;6(1):40.
10. Anchala R, Kannuri NK, Pant H, Khan H, Franco OH, Di Angelantonio E, et al. Hypertension in India: a systematic review and meta-analysis of prevalence, awareness, and control of hypertension. J Hypertens. 2014;32(6):1170–7. Available from: https://pubmed.ncbi.nlm.nih.gov/24621804
11. Liu M-Y, Li N, Li WA, Khan H. Association between psychosocial stress and hypertension: a systematic review and meta-analysis. Neurol Res. 2017;39(6):573–80. Available from: http://dx.doi.org/10.1080/01616412.2017.1317904
12. Malaysia M. National Health & Morbidity Survey 2015 non-communicable diseases, risk factors & other health problems.
13. Buford TW. Hypertension and aging. Ageing Res Rev. 2016/02/01. 2016;26:96–111. Available from: https://pubmed.ncbi.nlm.nih.gov/26835847
14. Liew SJ, Lee JT, Tan CS, Koh CHG, Van Dam R, Müller-Riemenschneider F. 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):e025869–e025869. Available from: https://pubmed.ncbi.nlm.nih.gov/31110091
15. Abebe SM, Berhane Y, Worku A, Getachew A. Prevalence and associated factors of hypertension: a crossectional community based study in northwest ethiopia. PLoS One. 2015;10(4):e0125210–e0125210. Available from: https://pubmed.ncbi.nlm.nih.gov/25909382
16. Sabaka P, Dukat A, Gajdosik J, Bendzala M, Caprnda M, Simko F. The effects of body weight loss and gain on arterial hypertension control: an observational prospective study. Eur J Med Res. 2017;22(1):43. Available from: https://pubmed.ncbi.nlm.nih.gov/29070064
17. Ng C-W, Shahari MR, Mariapun J, Hairi NNM, Rampal S, Mahal A. Universal Coverage of Hypertension Treatment Services in Malaysia Is Still an Elusive Goal. Heal Syst Reform. 2017;3(3):159–70. Available from: http://dx.doi.org/10.1080/23288604.2017.1342746
18. Timpson NJ, Harbord R, Davey Smith G, Zacho J, Tybjærg-Hansen A, Nordestgaard BG. Does Greater Adiposity Increase Blood Pressure and Hypertension Risk? Hypertension. 2009;54(1):84–90. Available from: http://dx.doi.org/10.1161/hypertensionaha.109.130005
19. Winnicki M, Bonso E, Dorigatti F, Longo D, Zaetta V, Mattarei M, et al. Effect of Body Weight Loss on Blood Pressure After 6 Years of Follow-Up in Stage 1 Hypertension. Am J Hypertens. 2006;19(11):1103–9. Available from: http://dx.doi.org/10.1016/j.amjhyper.2006.04.016
20. Loh KW, Rani F, Chan TC, Loh HY, Ng CW, Moy FM. The association between risk factors and hypertension in perak, malaysia. Med J Malaysia. 2013;68(4):291–6.
21. Teh CH, Chan YY, Lim KH, Kee CC, Lim KK, Yeo PS, et al. Association of physical activity with blood pressure and blood glucose among Malaysian adults: a population-based study. BMC Public Health. 2015;15:1205. Available from: https://pubmed.ncbi.nlm.nih.gov/26630916
22. Thompson PD, Crouse SF, Goodpaster B, Kelley D, Moyna N, Pescatello L. The acute versus the chronic response to exercise. Med Sci Sports Exerc. 2001;33(Supplement):S438–45. Available from: http://dx.doi.org/10.1097/00005768-200106001-00012

23. Pescatello LS, Franklin BA, Fagard R, Farquhar WB, Kelley GA, Ray CA. Exercise and Hypertension. Med Sci Sport Exerc. 2004;36(3):533–53. Available from: http://dx.doi.org/10.1249/01.mss.0000115224.88514.3a
24. Hegde SM, Solomon SD. Influence of Physical Activity on Hypertension and Cardiac Structure and Function. Curr Hypertens Rep. 2015;17(10):77. Available from: https://pubmed.ncbi.nlm.nih.gov/26277725
25. Korsager Larsen M, Matchkov V V. Hypertension and physical exercise: The role of oxidative stress. Medicina (B Aires). 2016;52(1):19–27. Available from: http://dx.doi.org/10.1016/j.medici.2016.01.005
26. Lelong H, Galan P, Kesse-Guyot E, Fezeu L, Hercberg S, Blacher J. Relationship Between Nutrition and Blood Pressure: A Cross-Sectional Analysis from the NutriNet-Sante Study, a French Web-based Cohort Study. Am J Hypertens. 2014;28(3):362–71. Available from: http://dx.doi.org/10.1093/ajh/hpu164
27. Hochkogler CM, Lieder B, Rust P, Berry D, Meier SM, Pignitter M, et al. A 12-week intervention with nonivamide, a TRPV1 agonist, prevents a dietary-induced body fat gain and increases peripheral serotonin in moderately overweight subjects. Mol Nutr Food Res. 2017;61(5):1600731. Available from: http://dx.doi.org/10.1002/mnfr.201600731
28. Di Chiara T, Scaglione A, Corrao S, Argano C, Pinto A, Scaglione R. Education and hypertension: impact on global cardiovascular risk. Acta Cardiol. 2017;72(5):507–13. Available from: http://dx.doi.org/10.1080/00015385.2017.1297626
29. Chen W-S, Haniff J, Siau C-S, Seet W, Loh S-F, Abd Jamil MH, et al. Psychometric Properties of the Malay Work-Related Quality of Life (WRQoL) Scale in Malaysia. World J Soc Sci Res. 2014;1(1):57. Available from: http://dx.doi.org/10.22158/wjssr.v1n1p57