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Predictors of Uncontrolled Hypertension among Patients Receiving Treatment from Public Primary Care Clinics in Pulau Pinang, Malaysia

Tan Hooi Shyuan[1,2], Ahmad Azuhairi Ariffin[1], Nor Afiah Mohd Zulkefli[1], Feisul Idzwan Mustapha[3]

[1] Department of Community Health, Faculty of Medicine and Health Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia
[2] Ministry of Health
[3] Ministry of Health Malaysia Disease Control Division, Wilayah Persekutuan, 62000 Putrajaya, Malaysia

ABSTRACT

Introduction: Hypertension treatment aims to reduce morbidity and mortality from cardiovascular and renal complications. In Malaysia, there is a high prevalence of uncontrolled hypertension among patients on treatment. This study aimed to identify the predictors of uncontrolled hypertension among patients receiving treatment from public primary care clinics in Pulau Pinang, Malaysia. **Methods:** An unmatched case-control study with 1:1 ratio was conducted among 334 hypertensive patients receiving treatment from selected public primary care clinics. Mean blood pressure measurements from the last two clinical visits were used to determine the hypertension status, and uncontrolled hypertension was defined as 140/90 mm Hg or higher. The cases were those with uncontrolled hypertension, while the controls were those with controlled hypertension. Participants were recruited by simple random sampling. Independent variables were sociodemographic factors, clinical and psychosocial factors, medication adherence, lifestyle modification, and clinical inertia. Data were collected using validated questionnaires and review of medical records. Multiple logistic regression analysis was performed by using IBM SPSS Statistics 25. **Results:** The mean age of respondents was 59 years (SD=11). Patients with medication non-adherence had 11.36 times higher odds of uncontrolled hypertension (aOR=11.36, 95% CI=6.59, 19.56, p<0.001). Clinical inertia increased 7.82 times the odds of uncontrolled hypertension (aOR=7.82, 95% CI=2.65, 23.09, p<0.001). **Conclusion:** Addressing medication adherence and clinical inertia are vital in reducing uncontrolled hypertension. The findings would help to prioritise interventions to improve the clinical management of hypertension and patient outcomes.

Keywords: Hypertension, Case-control studies, Medication adherence, Malaysia

Corresponding Author:
Ahmad Azuhairi Ariffin, MCMed (OH)
Email: zuhairifin@upm.edu.my
Tel: +603-97692424

INTRODUCTION

Hypertension is a major public health concern. It is the leading preventable risk factor for premature death and disability worldwide, primarily due to cardiovascular diseases and stroke (1). Globally, it was estimated that 31.1% of adults had hypertension in 2010 (2). Malaysia, which is an upper-middle income country, shares a similar scenario with the global statistics. Ischaemic heart disease and stroke are the leading causes of premature death in the country, with 30.3% of Malaysian adults or 6 million people are living with hypertension (3,4). Hypertension must be adequately treated to a certain blood pressure goal to reduce vascular morbidity and mortality (5).

Hypertension control is generally defined as the reading of blood pressure of less than 140/90 mm Hg in uncomplicated cases (6). Despite of having an effective treatment, only 37.1% of people worldwide achieve targeted blood pressure control with medication. The proportion was two times higher in high-income countries compared to low- and middle-income countries, with 50.4% and 26.3% respectively (2). To highlight the issue, the World Health Organization recommends to include the percentage of people whose hypertension is controlled by medication as part of the tracer indicator in monitoring essential health coverage for cardiovascular disease prevention within the Sustainable Development Goals (7). In Malaysia, 81.2% of known hypertension patients are on treatment and 76% of treated patients are being managed in public healthcare facilities (3) that are highly subsidised with good availability of antihypertensive agents. However, blood pressure control among hypertensive patients on treatment remains suboptimal in the country, with the percentage reported in a

few studies ranging from 26.6% to 31% (8–10).

Literature suggests that multiple factors are associated with hypertension control. With regards to sociodemographic factors, the associations between age, gender, ethnicity and hypertension control from previous studies are inconsistent (2,9–12). Higher educational level is associated with better hypertension control (9,10). As for clinical factors, an increased number of anti-hypertensive agents is associated with uncontrolled hypertension (13,14). Stress has been associated with medication non-adherence (15), although little is known about the association between stress, depression, anxiety and hypertension control. A number of studies reported a significant association between medication adherence and hypertension control (16–18). In terms of lifestyle modification, high dietary salt intake is associated with uncontrolled hypertension (19). However, the association between smoking and hypertension control is inconsistent (10,12,14), with scarce data on the association between physical activity, alcohol consumption and hypertension control. Despite the existence of guidelines on the management of hypertension, the clinical inertia or lack of active management, is known to be associated with uncontrolled hypertension (20). A few studies found that adherence to the guideline and appropriate intensification of treatment were associated with controlled hypertension (11,21).

Most of the previous studies on hypertension control in Malaysia were cross-sectional studies, in which the study design was mainly used to determine the prevalence. In this paper we describe the use of a case-control study to identify the predictors of uncontrolled hypertension among hypertensive patients receiving treatment from public primary care clinics in a district of Pulau Pinang, Malaysia. The findings would help to prioritise interventions to improve the clinical management of hypertension and patient outcomes.

MATERIALS AND METHODS

Study design, setting and sample selection

A clinic-based unmatched case-control study was conducted in all five public primary care clinics in the Seberang Perai Tengah District, Pulau Pinang, Malaysia from November 2018 to April 2019. The study population was hypertensive patients aged 18 to 80 years old who received at least one year of treatment from any of the clinics. The study excluded patients who had defaulted appointments during the study period or their last visit to clinic more than six months from the sampling date, and those with diabetes mellitus, ischaemic heart disease, cerebrovascular disease or renal impairment. Hypertensive patients with other major diseases were excluded because they had different blood pressure targets. In addition, they may not able to recognise the exact effect of anti-hypertensive medication due to their complex medication regimens (22).

The sampling frame was obtained from the list of hypertensive patients from the clinic appointment system. The mean documented blood pressure readings from the last two clinic visits was used to determine the hypertension status. Cases were defined as patients with uncontrolled hypertension (≥140/90 mm Hg) and controls were patients with controlled hypertension (<140/90 mm Hg). The Schlesselman case control study formula was used to calculate the sample size (23) and the proportion values were obtained from the local study on hypertension control (21). A minimum sample size of 163 per group was required, assuming a type-1 error of 5% ($\alpha = 0.05$) and a power of 80%. Given a 20% possible non-response rate, the final sample size was 205 per group. As 1:1 ratio was used for the number of cases and controls, a total of 410 patients were selected from the appointment list by simple random sampling method using the random number generator in Excel.

Instruments

Two study instruments were used, a proforma to extract data from the patient's medical record and a questionnaire. The proforma included age, gender, ethnicity, blood pressure readings, body mass index, number and frequency of anti-hypertensive agents used, and clinical inertia assessment. Clinical inertia was present when no active management was performed as recommended in the Malaysian Clinical Practice Guideline on Hypertension (24) when the patient had uncontrolled blood pressure during any follow-up visits in the past one year without a documented reason or refusal by the patient. Active management included increasing the dose of the anti-hypertensive agent; replacing the initial anti-hypertensive agent with another class; adding another anti-hypertensive agent; assessing patient adherence to the medication; or advising on lifestyle modification.

The questionnaire consisted of seven sections. The first section was on additional sociodemographic and clinical data, including education level, living status, and hypertension duration. The second section was medication adherence assessment. As the Malay version of the Hill-Bone Compliance to High Blood Pressure Therapy Scale developed and tested for use in Malaysian primary healthcare settings did not conform to the structural, predictive validity and reliability of the original scale, thereby limiting its use in current study (25). With reference to the study findings, the medication adherence scale used in the current study removed items with poor correlation with remaining items and added two important items from other scales to reflect the non-adherence concept in Malaysia (16,26). The current eight items questionnaire used a four-point scale to indicate the frequency of medication taking behaviour over the past six months, 1=never, 2=rarely (once monthly or less), 3=sometimes (two to three times

a month) and 4=often (once weekly or more). The cut-off value was determined by the Receiver Operating Characteristic (ROC) curve, a total score of eight was classified as adherence, while a score of nine and above was classified as non-adherence.

The third section was dietary salt intake assessment with four items adapted from the reducing sodium intake behaviour subscale of Hill-Bone High Blood Pressure Therapy Compliance Scale and Malaysian MySalt study findings (27,28). The questionnaire used a four-point scale to indicate the frequency of high dietary salt intake over the past one week, 1=never, 2=rarely (two days or less), 3=sometimes (three to five days) and 4=often (six days or more). The dietary salt intake was categorised as low (score five and below), moderate (score six to eight) and high (score nine and above) based on the ROC curve.

The fourth section was physical activity level measured by the validated International Physical Activity Questionnaire (IPAQ) with seven items and was classified as low, moderate and high (29). The fifth section was smoking behaviour assessed by eight items adapted from the Malaysian National Health and Morbidity Survey and categorised as current smoker, former smoker and never smoker (3). The sixth section was alcohol consumption measured by three items adapted from Alcohol Use Disorders Identification Test (30). It assessed alcohol consumption over the past one year and categorised into current drinker and non-drinker. The final section assessed psychosocial factors by using the validated 21-item Depression, Anxiety and Stress Scale (DASS) and was categorised as normal and abnormal score (31).

Validity and reliability

The questionnaire was validated using both content and face validation. The panel of six specialists in the field of public health and family medicine independently assessed the validity of content on representativeness and clarity. The representativeness referred to the ability of each item to represent the study variable, while the clarity indicated the clear wording of each item (32). Corrections were made based on the ratings and additional recommendations. The face validity of the questionnaire was conducted among hypertensive patients receiving treatment from a primary care clinic outside the study sites. The questionnaire was refined based on their feedbacks, which were predominantly about the clarity and words used.

Construct validity and reliability tests were carried out on the medication adherence scale and dietary salt intake scale, which have been adapted from several questionnaires. The exploratory factor analysis revealed a two-component structure within the medication adherence scale. The two components represented intentional non-adherence and unintentional non-adherence, and explained 38.4% and 17.5% of the variance, respectively. The eight-item medication adherence scale showed good internal consistency with the Cronbach's alpha value of 0.70. With respect to the dietary salt Intake Scale, the exploratory factor analysis revealed a single component that explained 50.9% of the variance and the Cronbach's alpha value was 0.66.

Data collection procedure

The informed consent of the participants was obtained prior to the data collection. The interviewer-assisted method was used because a large proportion of participants were in the older age group, some of whom had poor vision or reading skills. The principal investigator, who was not the treating physician, was the only interviewer in the data collection process, thereby avoiding inter-interviewer bias. The questions were read as written and in the exact order so that the results are comparable. Responses were recorded by either the participant or the interviewer. Additional information or comments from the participants were noted, which served as valuable information during interpretation of the results. Before the end of the session, the questionnaire was checked for completeness. This included obtaining data directly from the participants if the data were missing in the proforma due to incomplete documentation in the medical records. The average response time needed was 15 minutes.

Ethical consideration

The ethical approval of the study was obtained from the Medical Research and Ethics Committee (MREC) of the Ministry of Health of Malaysia on 25 October 2018 with reference number NMRR-18-2592-42309.

Data analysis

Statistical analysis was performed by using IBM SPSS 25 for Windows software package. Descriptive analysis was done to show the distribution of variables. Categorical variables were presented in frequency and percentages, while continuous variables were presented in mean and standard deviations. The Chi-square and Independent T-tests were used to compare the variables between the cases and the controls. Simple logistic regression analysis was performed to show the association between variables and uncontrolled hypertension. Subsequently, variables with p value < 0.25 from simple logistic regression were selected for multiple logistic regression to determine the predictors of uncontrolled hypertension (33). Three methods of variable selection including forward selection, backward elimination, and enter method were used to select the most fit model. A two-sided p value of < 0.05 and a 95% confidence interval which did not include a null value were considered statistically significant.

RESULTS

Of the total 410 patients recruited, there were 334

patients agreed to participate, making the response rate 81.5%. The main reason for non-response was the refusal to participate due to time constraints, as either they or their caregivers had to go to work after the follow-up visits. Participants age ranged from 21 to 79 years (mean=59.4, SD=11.4). Both groups had a higher percentage of females, Malay ethnicity, secondary education, and stayed with the family (Table I). Among the cases, 55.1% had hypertension for more than 5 years, 61.1% had two or more anti-hypertensive agents and 93.4% had once daily medication regimens (Table II). While 56.7% of the controls had hypertension for more than 5 years, 49.1% had two or more anti-hypertensive agents and 90.4% had once daily medication regimens.

Table I: Sociodemographic characteristics of participants

Variables	Cases (n=167) n (%)	Controls (n=167) n (%)	χ^2 test (*df*)	*p* value
Age (years)	59.8 (11.2)[1]	59.0 (11.5)[1]	0.682 (332)[2]	0.496
Gender			0.199 (1)	0.655
Male	65 (38.9)	69 (41.3)		
Female	102 (61.1)	98 (58.7)		
Ethnicity			1.469 (2)	0.480
Malay	91 (54.5)	85 (50.9)		
Chinese	60 (35.9)	59 (35.3)		
Indian	16 (9.6)	23 (13.8)		
Educational Level			0.866 (4)	0.929
No formal education	6 (3.6)	7 (4.2)		
Primary	52 (31.1)	47 (28.1)		
Secondary	84 (50.3)	91 (54.5)		
Pre-university	10 (6.0)	8 (4.8)		
Tertiary	15 (9.0)	14 (8.4)		
Living status			0.363 (1)	0.547
Staying with family	152 (91.0)	155 (92.8)		
Staying alone or in care institution	15 (9.0)	12 (7.2)		

[1] mean (SD) [2] t(df)

The prevalence of overweight and obesity among participants was high with 82% of cases and 77.8% of controls (Table II). The percentage of DASS abnormal scores for depression, anxiety and stress ranged from 6.0% to 12.0% for cases, and 6.0% to 10.2% for controls. High dietary salt intake was reported in 25.7% of cases and 18.6% of controls. The prevalence of low level of physical activity was high with 42.5% of cases and 46.1% of controls. There were 12.0% of cases and 13.2% of controls were current smokers, while 18.0% of cases and 13.8% of controls consumed alcohol. It was found that 83.2% of cases were non-adherent to medication as compared to 30.5% of controls. The mean number of follow-up visits per year for cases was 4.2 (SD=1.2) and 3.8 (SD=1.1) for controls. Clinical

Table II: Clinical factors, psychosocial factors, medication adherence and lifestyle modification of participants

Variables	Cases (n=167) n (%)	Controls (n=167) n (%)	χ^2 test (*df*)	*p* value
Duration of hypertension (years)			0.221 (2)	0.896
<5	75 (44.9)	73 (43.7)		
5-10	59 (35.3)	63 (37.7)		
>10	33 (19.8)	31 (18.6)		
Number of AHA[1] types used			4.841 (1)	0.028*
One	65 (38.9)	85 (50.9)		
Two or more	102 (61.1)	82 (49.1)		
Daily dose frequency of AHA[1]			1.007 (1)	0.316
Once	156 (93.4)	151 (90.4)		
Twice or more	11 (6.6)	16 (9.6)		
Body Mass Index			3.748 (2)	0.154
Normal	30 (18.0)	37 (22.2)		
Overweight	66 (39.5)	76 (45.5)		
Obese	71 (42.5)	54 (32.3)		
Depression			0.320 (1)	0.572
Abnormal score	14 (8.4)	17 (10.2)		
Normal score	153 (91.6)	150 (89.8)		
Anxiety			3.662 (1)	0.056
Abnormal score	20 (12.0)	10 (6.0)		
Normal score	147 (88.0)	157 (94.0)		
Stress			0.420 (1)	0.517
Abnormal score	10 (6.0)	13 (7.8)		
Normal score	157 (94)	154 (92.2)		
Dietary salt intake			2.724 (2)	0.256
Low	52 (31.1)	61 (36.5)		
Moderate	72 (43.1)	75 (44.9)		
High	43 (25.7)	31 (18.6)		
Physical activity level			0.487 (2)	0.784
Low	71 (42.5)	77 (46.1)		
Moderate	81(48.5)	77 (46.1)		
High	15 (9.0)	13(7.8)		
Smoking status			2.173 (2)	0.337
Current smoker	20 (12.0)	22 (13.2)		
Former smoker	15 (9.0)	23 (13.8)		
Never smoker	132 (79.0)	122 (73.0)		
Alcohol Consumption			1.099 (1)	0.295
Current drinker	30 (18.0)	23 (13.8)		
Non-drinker	137 (82.0)	144 (86.2)		
Medication adherence			94.536 (1)	<0.001*
Adherence	28 (16.8)	116 (69.5)		
Non-adherence	139 (83.2)	51 (30.5)		
Number of follow-up visits per year	4.2 (1.2)[2]	3.8 (1.1)[2]		
Clinical inertia			22.157 (1)	<0.001*
Presence	32 (19.2)	5 (3.0)		
Absence	135 (80.8)	162 (97.0)		

*$p < 0.05$ level (2-tailed)
[1]AHA: Anti-hypertensive agents
[2] mean (*SD*)

inertia was found in 19.2% of cases and 3% of controls.

Simple logistic regression analysis found that those with two or more antihypertensive agents increased the odds of uncontrolled hypertension by 1.6 times as compared to those with one antihypertensive agent (OR=1.63, 95% CI=1.05, 2.51, p=0.028). Non-adherence to medication increased the odds of uncontrolled hypertension by 11.29 times (OR=11.29, 95% CI=6.69, 19.05, p<0.001), and clinical inertia increased the odds of uncontrolled hypertension by 7.68 times (OR=7.68, 95% CI=2.91, 20.26, p<0.001). Other variables showed no significant results, including sociodemographic factors, duration of hypertension, body mass index, daily dose frequency of medication, psychosocial factors, and lifestyle modification (Table III & IV).

Table III: Association of uncontrolled hypertension with sociodemographic factors by simple logistic regression analysis

Variables	Regression coefficient (b)	Crude odd ratio (95% CI)	Wald statistic	*p* value
Age (years)	0.01	1.01 (0.99, 1.03)	0.47	0.494
Gender				
Male	0	1		
Female	0.10	1.11 (0.71, 1.71)	0.20	0.655
Ethnicity				
Malay	0.43	1.54 (0.76, 3.11)	1.44	0.230
Chinese	0.38	1.46 (0.70, 3.04)	1.03	0.309
Indian	0	1		
Educational Level				
No formal education	-0.22	0.80 (0.22, 2.97)	0.11	0.739
Primary	0.03	1.03 (0.45, 2.36)	0.01	0.939
Secondary	-0.15	0.86 (0.39, 1.89)	0.14	0.710
Pre-university	0.15	1.17 (0.36, 3.80)	0.07	0.798
Tertiary	0	1		
Living status				
With family	0	1		
Alone or in care institution	0.24	1.28 (0.58, 2.81)	0.36	0.548

*$p < 0.05$ level (2-tailed)

From the simple logistic regression analysis, variables with p value < 0.25 were included for multiple logistic regression (33). Eight variables were selected, including ethnicity, body mass index, anxiety, number of antihypertensive agent types used, medication adherence, dietary salt intake, smoking status, and clinical inertia. The forward selection with likelihood ratio method appeared to be the most fit model. There was no multicollinearity, with a small correlation between the

Table IV: Association of uncontrolled hypertension with clinical factors, psychosocial factors, medication adherence and clinical inertia by simple logistic regression analysis

Variables	Regression coefficient (b)	Crude odd ratio (95% CI)	Wald statistic	*p* value
Duration of hypertension (years)				
<5	0	1		
5-10	-0.09	0.91 (0.56, 1.47)	0.14	0.705
>10	0.04	1.04 (0.58, 1.86)	0.01	0.906
Number of AHA[1] types used				
One	0	1		
Two or more	0.49	1.63 (1.05, 2.51)	4.82	0.028*
Daily dose frequency of AHA[1]				
Once	0.41	1.50 (0.68, 3.34)	1.00	0.318
Twice or more	0	1		
Body Mass Index				
Normal	0	1		
Overweight	0.07	0.82 (0.60, 1.92)	0.05	0.818
Obese	0.48	0.11 (0.89, 2.95)	2.51	0.113
Depression				
Abnormal score	-0.21	0.81 (0.38, 1.70)	0.32	0.572
Normal score	0	1		
Anxiety				
Abnormal score	0.76	2.14 (0.97, 4.72)	3.53	0.060
Normal score	0	1		
Stress				
Abnormal score	-0.28	0.76 (0.32, 1.77)	0.42	0.518
Normal score	0	1		
Dietary salt intake				
Low	0	1		
Moderate	0.12	1.13 (0.69, 1.84)	0.23	0.636
High	0.49	1.63 (0.90, 2.94)	2.60	0.107
Physical activity level				
Low	-0.22	0.80 (0.36, 1.80)	0.30	0.587
Moderate	-0.09	0.91 (0.41, 2.04)	0.05	0.822
High	0	1		
Smoking status				
Current smoker	-0.17	0.84 (0.43, 1.62)	0.27	0.602
Former smoker	-0.51	0.60 (0.30, 1.21)	2.04	0.154
Never smoker	0	1		
Alcohol Consumption				
Current drinker	0.32	1.37 (0.76, 2.48)	1.09	0.296
Non-drinker	0	1		
Medication adherence				
Adherence	0	1		
Non-adherence	2.42	11.29 (6.69, 19.05)	82.60	<0.001**
Clinical inertia				
Presence	2.04	7.68 (2.91, 20.26)	16.98	<0.001**
Absence	0	1		

*$p < 0.05$ level (2-tailed), ** $p < 0.001$ level (2-tailed)
[1]AHA: Anti-hypertensive agents

variables (r =0.13) and a variance inflation factor of less than 10. No significant interaction effect was noted in the model (p=0.585).

Only two variables, namely medication adherence and clinical inertia, were found to be significant in the final model. Hypertensive patients with medication non-adherence had 11.36 times the odds of having uncontrolled hypertension (aOR=11.36, 95% CI=6.59, 19.56, p<0.001) when adjusted for clinical inertia. It also showed that hypertensive patients experienced clinical inertia had 7.82 times the odds of having uncontrolled hypertension (aOR=7.82, 95% CI=2.65, 23.09, p<0.001) when adjusted for medication non-adherence (Table V). The model explained 40% of the variance in uncontrolled hypertension (Nagelkerke R square= 0.40) and was able to correctly classify 76.6% (95% CI=71.73, 81.08) of the subjects. The Hosmer-Lemeshow Goodness-of-Fit Test showed a good fit of the model (p=0.859).

Table V: Predictors of uncontrolled hypertension by multiple logistic regression model

Variables	Regression coefficient (b)	Standard error (SE)	Adjusted odd ratio (95% CI) [a]	Wald statistic	*p* value
Medication adherence					
Adherence	0		1		<0.001**
Non-adherence	2.43	0.28	11.36 (6.59, 19.56)	76.66	
Clinical inertia					
Presence	2.06	0.55	7.82 (2.65, 23.09)	13.87	<0.001**
Absence	0		1		
Constant	-1.61				

** *p* <0.001 level (2-tailed)
[a] Forward likelihood ratio multiple regression model was applied

DISCUSSION

The current study aimed to identify predictors of uncontrolled hypertension among patients on treatment in response to high prevalence of uncontrolled hypertension in Malaysia. Sociodemographic factors, including age, gender, ethnicity, educational level and living status, have not been found to be significantly associated with uncontrolled hypertension. The results showed that the case and control groups shared similar sociodemographic characteristics. Among the variables investigated, medication non-adherence and clinical inertia were found to be significant predictors of uncontrolled hypertension by using multiple logistic regression. Despite the lack of precision in odds ratio due to the small sample size of hypertensive patients with medication non-adherence and clinical inertia indicated by a wide confidence interval, the findings are useful to provide insight into uncontrolled hypertension.

Medication non-adherence is a predictor of uncontrolled hypertension consistent with the results of previous studies (16–18). Medication non-adherence is the main reason why treatment that has been shown to be efficacious in randomised clinical trials is often less effective in real clinical practice (34). It has been widely described as either intentional or unintentional because of the different factors associated with each and the need for different tailored solutions (25,34–36). Intentional non-adherence refers to a process in which the patient consciously decides not to use the medication or not to follow the prescribed regimen. Unintentional non-adherence, on the other hand, is an unplanned passive process and involves factors beyond the control of the patient (34,35). The medication adherence scale used in current study is able to assess these two components of non-adherence behaviour.

There are four items that imply unintentional non-adherence, including forgetfulness, skipped as running out of medication, skipped as forgotten to bring along when away from home, and skipped before going to see their physician. Forgetfulness was the most common reason of non-adherence among participants in current study, which could be due to difficulties in making it a habit, as reported in a systematic review of qualitative and quantitative studies on barriers to hypertension therapy (37). Intervention to improve medication self-management skills is needed to help patients remember to take medication by integrating it into their daily routine (35). Patients may benefit from the use of pill boxes to organise their medication by day of the week and timing for each pill, or using calendars or telephone reminders to help them remember to take their medication at the right time (38). Healthcare providers may also help to remind patients of timely medication refills by sending text messages to their mobile phones (34).

The other four items in the medication adherence scale involve the intentional non-adherence, including not taking medication by decision, skipping when feeling better, skipping when feeling sick, and changing the dose of medication. One of the common reasons for the intentional non-adherence is misperception of hypertension and its medication (22,39). Previous studies found that patients stopped their anti-hypertensive agents because they perceived hypertension as a temporary and curable condition but not a life-long illness (22,36,40,41) or believed that they did not need medication because they had no symptoms (37). Experienced side effects of anti-hypertensive agents have also been shown to be a common reason of non-adherence (36,40). Educational intervention to improve adherence to medication should therefore address patients' perceptions of hypertension and medication rather than simply focusing on the provision of knowledge.

In the current study, clinical inertia was found to be the

significant predictor of uncontrolled hypertension. The different operational definitions and methodologies used to report clinical inertia in previous studies have made comparisons difficult. Philips et al. first introduced the term clinical inertia in 2001, which was defined as the failure of physicians to initiate or intensify therapy when appropriate (42). This study recognised the assessment of medication adherence and lifestyle modification advice as active management of hypertension care, in addition to the intensification of pharmacological therapy. Another extension of the definition of clinical inertia in the current study is to take into account the refusal of patients to step up therapy and the documented justifications. Previous literature suggested that uncertainty about the true value of blood pressure, such as when the patient reported home blood pressure readings meeting the target, was a common reason why therapy remained unchanged (43).

Despite some minor differences in the definition of clinical inertia in previous studies, this result is consistent with the previous findings. A study in Florida found that 66% of all newly diagnosed hypertensive patients had clinical inertia at least once during the study period. Clinical inertia reported in the study was associated with almost 3 times the odds of uncontrolled blood pressure in hypertensive patients (20). In Malaysia, a few studies focused on the adherence of physicians to the clinical practice guideline in prescribing the first-line anti-hypertensive agent. A cross-sectional study with prescription data and medical records in a tertiary hospital found that adherence to guideline was a significant predictor that increased the odds of controlled hypertension by 1.7 times (21). Another study conducted at health clinics in Kedah, Malaysia, found that hypertensive patients receiving appropriate intensification of treatment were 2 times more likely to have controlled hypertension (11).

The current study was unable to detect the association between body mass index and uncontrolled hypertension. From the descriptive analysis, the majority of hypertensive patients were either overweight or obese, accounting for 82% of cases and 78% of controls. The result is consistent with the REDISCOVER study in Malaysia, that found no significant association between body mass index and hypertension control (10). There was no significant association between psychosocial factors, which were stress, anxiety and depression, and uncontrolled hypertension. A systematic review of psychosocial risk factors for hypertension including 21 cohort or case-control studies, found inconsistent association between mental health and hypertension (44). However, the comparison of findings was complicated by the different assessment tools used in previous studies to measure the state of mental health.

The current study found no significant association between uncontrolled hypertension and lifestyle modification, including dietary diet intake, physical activity, smoking, and alcohol consumption. The results are consistent with a community-based study in Nepal that found no statistically significant association between hypertension control and healthy behaviours (45). The descriptive analysis of this study showed a similar proportion of cases and controls with high dietary salt intake (25.7% versus 18.6%) and low level of physical activity (42.5% versus 46.1%). Despite studies showing benefits of lowering blood pressure with reduced dietary salt intake and increased physical activity (46–48), this study showed widespread non-compliance with lifestyle modification among the participants, regardless of their status of hypertension control. As reported in a qualitative study, most of the hypertensive patients were reluctant to make major disruptive lifestyle changes. They found it easier to take medication than to change their diet, to stop smoking, or to be more physically active in controlling their blood pressure (40). Moreover, it is widely believed that the change in diet is particularly difficult to embrace with abundant and easily accessible Malaysian foods that are high in oil, salt and sugar (41).

The implications of this study includes enhancing the understanding of uncontrolled hypertension among patients receiving treatment from public primary care clinics that could be used to inform policy, practice and intervention. The findings have shown that a combination of different approaches is needed to improve the control of hypertension. One of the important implications is that both the medication adherence and clinical inertia should be taken into account when designing the intervention for this purpose.

It is recommended that the medication adherence assessment for all hypertensive patients with a short and validated questionnaire to be included in the clinical practice guideline. Proactive screening of medication adherence and related issues could serve as the initial step towards improving adherence and subsequently the control of hypertension. Interventions to enhance medication adherence should be tailored to the needs of the patient on the basis of either unintentional or intentional non-adherence or both. It is important to develop patient self-management skills so that they can remember to take and handle their medications better by incorporating them into their daily routine. Educational intervention should address patients' perceptions of hypertension and medications in order to reduce the intentional non-adherence. In addition, the evaluation of clinical inertia is recommended as part of the quality control and performance monitoring programme in public primary care clinics. Interventions to overcome clinical inertia should focus on the contributing factors involving patients, providers and the healthcare system, which ultimately aim at improving the control of hypertension.

One of the strengths of this study is to have two equal

groups by using a case-control approach to maximise the power to detect a significant difference. The case-control approach has also made it possible to identify the predictors of uncontrolled hypertension with its relative importance by calculating the odds ratio, which could help to prioritise the specific management plan and the counselling content of each follow-up visit for better patient outcomes.

The interviewer-assisted method used to collect data from participants improved the response rate and data quality. The possibility of missing data and misinterpretation of the questions being asked has been minimised. However, this method may be subject to socially desirable response bias, particularly in the assessment of medication adherence. In order to reduce the bias, the interviewer asked questions in a non-judgmental manner and normalised non-adherence by recognising the difficulties of adhering to medication.

The use of the questionnaire is limited by recall bias. The medication adherence scale has the longest recall period of six months, although this has been done with the aim of optimising response options. Since the hypertension control in this study was determined by mean blood pressure readings during the last two visits, an average of three to four months apart, a longer recall period was required to establish a meaningful association. In addition, the different time frames for recall periods used in the respective sections of the questionnaire may appear unclear to participants and therefore require further emphasis and clarification from the interviewer. Due to this limitation, it is recommended that the questionnaire in this study to be used as an interviewer-assisted measure rather than a self-reported measure.

Due to limited time and resources, the current study did not examine the association of health system factors with uncontrolled hypertension. Finally, as the study involved only public primary care clinics in a district of Pulau Pinang, Malaysia, the generalisability of these findings is therefore limited.

For future studies, a qualitative approach is recommended to explore the perceptions and experiences of patients and healthcare providers in the management of uncontrolled hypertension, as in-depth findings can help to enhance the contents of a tailored intervention programme. Patients and healthcare providers may have different perspectives on certain health issues which could be seen as complementary, so that a mutually acceptable strategy for hypertension care improvement can be put in place. Moreover, it is valuable to explore the factors of clinical inertia among healthcare providers, as they traditionally play a more dominant role in clinical management and influence the patient-provider relationships. Future studies are also recommended to critically examine knowledge on what we have already known but do not apply in clinical practice, including addressing the barriers that patients may encounter in their efforts to maintain blood pressure and optimal health.

CONCLUSION

The study findings suggest that priority should be given to improving medication adherence and reducing clinical inertia in the management of uncontrolled hypertension. A routine assessment of medication adherence is recommended during follow-up visits by using a short and validated questionnaire. In addition, the evaluation of clinical inertia should be included in the hypertension quality assurance programme in public primary care clinics. Despite the lack of a significant relationship between lifestyle modification and uncontrolled hypertension, the clinical significance of lifestyle modification cannot be denied. In fact, these statistically insignificant results indicated that most hypertensive patients, regardless of their hypertension status, were reluctant to make major lifestyle changes. Therefore, more effort is needed to encourage lifestyle modification, in view of the enormous health benefits that it could offer in addition to hypertension control.

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