

Improvement of nutritional intake for the low-income urban dwellers with hypertension in Malaysia

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Abstract

Objective: To ascertain the effect of dietary practice modification and a peer-support home blood pressure monitoring program on the nutritional intake (macronutrients and micronutrients), blood pressure and biochemical profiles of hypertension patients in a low-income community setting.

Methods: This is a pre- and post-measurement intervention study conducted in low-income community housing projects in Kuala Lumpur, Malaysia. A total of 90 participants aged 18 years and above with hypertension received intervention. The participants were divided into small groups and received instructions on the use of home blood pressure measurement. They also attended a series of talks on dietary intake modification and exercise demonstration for the first six months (active phase). In another 6 months (maintenance phase), they received only pamphlet and SMS reminders. Their anthropometry, blood pressure, dietary, and biochemical parameter changes were measured at baseline, 6 months, and 12 months of intervention.

Results: Macronutrients and micronutrients showed a significant improvement at the end of 12-month dietary intervention. The energy, carbohydrate, protein, total fat, sodium, and potassium are showing significant reduction from baseline to end of the 12-month intervention. There is no significant reduction in blood pressure. Fasting blood glucose, renal sodium, triglyceride, low-density lipoprotein cholesterol and high-density lipoprotein cholesterol showed a significant improvement, after controlling for age and reported physical activity.

Conclusion: The intervention improved the nutritional intake and biochemical profiles of the low-income urban population with hypertension. This promising result should be replicated in a larger scale study.

Keywords

Hypertension, low-income urban community, dietary modification, peer-support, blood pressure

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Introduction

Hypertension, one of the major non-communicable diseases (NCDs), is rapidly becoming a global burden. The prevalence of hypertension worldwide is estimated at around one billion or 26% of the adult population.¹ In Southeast Asia, almost 40% of adults aged 25 years and above have been diagnosed with hypertension.² Compared to high-income countries, hypertension causing mortality is higher in low- and middle-income countries due to the poor management of the health care system.²

In Malaysia, the prevalence of hypertension is 32.7% among the population aged 18 years and above and among the leading causes of cardiovascular-related death such as heart disease and stroke.³ The National Health and Morbidity Survey (NHMS) recorded an increasing prevalence of hypertension among

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Malaysian from 32.9% in the year 1996 to 38.9% in the year 2015. Hypertension prevalence in urban settings increased from 29.3% in 2006 to 30.9% in 2011. Notably, the increment in hypertension prevalence was statistically significant in urban but not for the rural areas. A cross-sectional study in Malaysia found that only 34.6% of hypertension patients are a known hypertension, with only 26.8% of them had their medication and well-controlled blood pressure.⁴ According to a study conducted in outpatient's clinics around Klang Valley area, majority of the hypertensive patients (71.6% out of 74 hypertensive subjects) had poor blood pressure control, with poor dietary control. This study also showed that more than 60% of the subjects were consuming more than 2400 mg sodium per day.⁵ Their sodium intake was more than World Health Organization (WHO) recommendation of 2000 mg per day for blood pressure reduction and lowering the risk of cardiovascular diseases.² These statistics underline the need to implement immediate measures in the Malaysian population, particularly among the urban residents.

Lifestyle factors such as a high intake of food high in fat and salt, a low fiber intake, minimal physical activity, and a lack of stress management have been highlighted as risk factors for hypertension.² A qualitative study in hypertension patients in primary care settings in Malaysia found that insufficient information and lack of support from the community lead to patients' deciding not to follow hypertension care recommendations.⁶ Thus, the empowerment of patients with knowledge and hypertension management skills may help them in managing their hypertension.⁷ Moreover, modifying dietary practices and changes to behavior may lead to promising results in combating hypertension.²

Intervention studies have been conducted in various countries in order to combat the growing problem of hypertension and cardiovascular disease. For instance, as part of the wider Telemonitoring and Self-Management in Hypertension 2 (TASMINH 2) study, research conducted in 2013 within the UK primary practices showed that combining self-care with closed monitoring by physicians at primary clinics helped in lowering blood pressure by the end of 6-month intervention period.⁸ A cross-sectional study from a national cohort found that elderly, women, people who are physically active and non-alcohol drinker were the one who practiced the Dietary Approaches to Stop Hypertension (DASH) diet most. This may be attributable to the health-seeking knowledge behavior of this group.⁹ From the finding, providing knowledge to the hypertension patients regarding the DASH diet dietary may help in improving their blood pressure status. Similarly, a community-based intervention study conducted in rural China for a 3-year period, which provided healthcare staff with educational material suitable for the community, showed promising results, especially in controlling intakes of fat and salt.¹⁰ Another intervention study in Shihlin, Taiwan, which focused on patients with hypertension and high cholesterol, found that there was an improvement in self-behavior such as adherence to medication and

doing exercise and maintaining physical fitness at the end of a 1-year community-based health promotion program.¹¹ In Malaysia, thus far there seems to be just one intervention study on combating cardiovascular risk factors in a community setting. However, the study was conducted on patients selected from a number of clinics in the Klang Valley. Therefore, the experimental setup focused on the participating clinics where they usually go for follow-up and received their health intervention rather than conducted in their own community housing.¹²

Although the Malaysian government substantially subsidizes healthcare provision, there are still cases of undiagnosed hypertension—a situation which is largely due to a lack of awareness among the population about the need for regular medical check-ups and a lack of ability to take care of their own health.^{13,14} Due to the high coverage of urban areas by private sector healthcare providers, people in urban areas have higher accessibility to healthcare compared to those in rural areas. However, only those who can afford it may have the benefits of private hospital while others have to depend on public hospitals which are overutilized.¹⁵ Also, due to the high cost of living in metropolitan area, low-income patients tend to skip regular check-ups at public healthcare centers even though the cost is relatively minimal.¹⁶ They also ignore the consequences of uncontrolled hypertension as they prioritize earning time over taking up the benefits the government has provided.^{3,16} However, good health and well-being is one of the main goals listed in the Sustainable Development Goals (SDGs) in order to transform the world into a better place. It is argued that changing lifestyle behavior can help in improving health and achieving the SDG targets.¹⁷ Due to this, the Ministry of Health Malaysia has launched National Strategic Plan for Non-Communicable Disease in order to reduce the burden of NCDs, hypertension included, with whole community approach strategies. Among the program they did was to establish baseline data on salt intake using 24-h urine collection and food frequency questionnaire (FFQ). This study was conducted among health care staff to determine their sodium intake and the sources of dietary sodium from their usual food intake.¹⁸ Therefore, this intervention study is designed to discover whether a community-based lifestyle intervention could help in reducing the prevalence of hypertension and improving the health of a low-income urban population. The main objective of this study is to measure the effectiveness of dietary practice modifications and a peer-support blood pressure monitoring program on the nutritional intake (macronutrients and micronutrients), blood pressure, and lipid profiles of individuals with hypertension in low-income urban populations in Malaysia.

Methods

Study design and setting

The study design was a community-based intervention with pre- and post-measurements. The participants of the study were residents of selected low-income community housing

projects in the Lembah Pantai area of Kuala Lumpur, the capital of Malaysia. In this study, the low-income urban population was selected as the population of interest because of the need to help reduce any disparities in health status and access to healthcare among the population. From six community housing projects in the area, three low-income housing communities were randomly selected. The initial intention was to conduct the study according to a protocol published elsewhere involving four randomly selected housing complex: two housing complex as intervention group and another two housing complex grouped as control.¹⁹ However, one housing complex has been dropped from sampling frame as the head of the block was unable to cooperate and assist during the study duration. Adding with low response rate with long recruitment period and completion, a pre- and post-design was chosen. This intervention has been addressed in the erratum of the initial protocol that was published.^{19,20} This intervention study was conducted for 12 months, from April 2013 to April 2014. The first six months were the active intervention phase, while another 6 months were the maintenance phase. Malaysian aged 18 years old and above, residents of the selected housing communities, diagnosed either with stage 1, 2, or 3 hypertension by a medical professional, able to speak Malay or English, willing to be involved in every aspect of the interventions, able to measure their own blood pressure, and able to do daily chores without limitation were included in this study. The classification of hypertension was following the Malaysian Clinical Practice Guideline: Management of Hypertension.²¹ Pregnancy, participating in another clinical trial, and staying at the selected low-income community less than a year were excluded from this study. Invitation letter to join this study was sent to selected residents who fulfilled these criteria.

Sample size calculation and recruitment

The sample size calculation was made by assuming a significant level of 5% and a power of 80% and was carried using the Power and Sample Size Calculations software version 3.0.43 (Creative Commons Attribution-NonCommercial-NoDerivs 3.0 United States). Paired *t*-test was used to calculate the sample size. A few studies that reported significant results and that used nearly the same design as this study were consulted in order to estimate the sample size for this study. Based on our review of the related literature, we chose to estimate the sample size for this study using the outcome (target of blood pressure changes of 5 mm Hg) from the study by Bennett et al. (2009).²² Furthermore, assuming a 30% dropout rate, we determined that a sample of 95 subjects was required.

Measurement

The respondents, who were all above 18 years of age, underwent the following baseline measurements: anthropometric measurements, blood pressure measurement, blood profiles, and dietary assessment.

Anthropometric measurement. The anthropometric measurements consisted of height (measured using a calibrated Seca 217 Stadiometer for Mobile Height Measurement and rounded to the nearest 1 mm), weight (measured using a calibrated Seca 813 Digital High-Capacity Floor Scale and rounded to the nearest 0.1 kg), and waist and hip circumferences (measured using a calibrated Seca 201 Ergonomic Measuring Tape (Seca, UK)). The body mass index (BMI) classification used was based on the WHO criteria pertaining to obesity in Asia.²³ Body fat percentage was measured to the nearest 0.1% using a calibrated Tanita SC-240 MA Portable Body Composition Analyzer (Tanita, Tokyo, Japan). Foot-to-foot bioelectrical impedance analysis (BIA) was chosen as it is convenient, simple to use, and produces reliable measurements of body fat percentage which significantly correlated with direct segmental multi-frequency (DSM) BIA.²⁴ The body fat percentage classification used in this study was based on the American College of Sports Medicine Guidelines.²⁵

Blood pressure measurement. The blood pressure measurement was taken using a calibrated Omron HEM-7211 Automatic Blood Pressure Monitor (Omron, Osaka, Japan). The blood pressure measurement was conducted according to the standardized procedure recommended for hypertension.²¹

Blood profiles. A certified medical doctor or nurse performed the blood sampling procedure. The participants were required to fast the night prior to the day of blood taking. Then, the blood sample was sent to a certified laboratory of a tertiary hospital. Random blood glucose, renal profile, and lipid profile tests were conducted.

Dietary assessment. For the dietary assessment, a 7-day diet history was chosen as the means by which to assess the nutritional and habitual dietary intake of the participants. This method was chosen because it can produce a more accurate estimation of dietary intake compared to other methods, and this method is also suitable in assessing dietary intake in low- and middle-income countries.²⁶ The 7-day diet history can capture the food and drinks consumed over the week and show variation of intake to provide an estimate intake for energy, macronutrients, and micronutrients of the participants. There was no available validated adult's Malay FFQ suitable for the low-income population; therefore, the 7-day diet history was the best method to use in this study.^{27,28} Pilot testing was conducted prior to this study to see the feasibility of using this method in assessing macronutrients and micronutrients of low-income population. Micronutrient and macronutrient intakes were calculated using the Nutritionist ProTM Diet Analysis software (Axxya Systems, Stafford, TX, USA).²⁹

Questionnaire

The demographic characteristics were collected, and the validated Malay version of the Global Physical Activity Questionnaire (GPAQ) was used to measure the level of

reported physical activity of each participant.³⁰ The GPAQ consists of 16 questions that cover three main domains as follows: activity at work, travel to and from places, and recreational activities.³¹

Intervention components

During the first six-month interventional period, the participants received training on how to self-monitor their blood pressure, four sessions of health coaching on healthy dietary practices and other lifestyle modifications, and four sessions on demonstration and training for indoor exercises. In the next 6 months, the participants received four pamphlets and four short message service (SMS) without any health coaching and talk. Pamphlets contained information on dietary modification for hypertension patients while SMS sent as reminder for them to keep measuring their blood pressure regularly.

Self-monitoring of blood pressure. Peer-support groups consisting of 6–10 persons per group were formed in each housing complex selected. A calibrated digital blood pressure monitor was distributed to each group, and participants were trained on how to measure blood pressure by themselves and how to record it in a logbook. A trained, registered nurse conducted training on the steps to use the blood pressure monitor. The logbook of each participant was checked during every health coaching session to see whether the participants had recorded the blood pressure correctly or not. The digital blood pressure monitors were calibrated by the authorized dealer to ensure the accuracy and functionality of the machines.

Coaching on healthy dietary practices and lifestyle modifications. Health coaching sessions were conducted with each group by a trained dietitian. Each group participated in four sessions over the first six months of the intervention period. Every session was conducted twice at each housing complex. This was to ensure that the participants can attend as each session was focusing on different topics. The sessions covered a range of healthy dietary practices and included a diet modification group talk with an emphasis on how to reduce sodium intake that was conducted by a dietitian. The topics of fiber intake, healthy recipe modification, reading food labels, and shopping guidance were covered in the various sessions in order to help the participants change their lifestyle to a healthier one. The DASH diet was used as guidelines to advise the participants in modifying their dietary intake. Besides, in the DASH diet, the recommended sodium intake was 1500 mg per day, which also in line with the WHO recommendation.^{32,33} In addition, a professional chef was in charge of handling the healthy cooking session which was a part of the health coaching session. Typical Malaysian cuisines were modified into a healthier version to suit hypertensive patients. Stress management, smoking cessation, and alcohol reduction were also among the topics

discussed with the participants during the health coaching sessions. In addition, a 7-day diet history was taken from each participant at the baseline, 6 months, and 12 months in order to detect any changes following the intervention. While in the maintenance phase, the participant only received pamphlet and SMS reminder once every month.

Indoor exercise demonstration and training. The participants also attended four sessions of exercise and physical activity training. In the first session, a talk on the benefit of an active lifestyle and demonstration on how to perform exercise regularly were provided by an exercise physiologist. This was followed by three training sessions that have been conducted during the first six months of active intervention in order to guide the participants on how to exercise. An exercise compact disc (exercise CD) was also provided to each of the participants to help them to exercise on their own. The participants were also trained to record their own physical activity in a logbook that was given to each participant. A BMI calculator was also provided to each participant to help the participants to calculate their own BMI.

Pamphlet and SMS. Another 6 months after the active intervention period were the maintenance phase. During this period, the participants only received pamphlets and SMS reminder, without any health coaching sessions and exercise training. Among topic listed in pamphlets including steps to reduce salt and reading food labels. They also received four SMS reminders on blood pressure monitoring. The participants also encouraged to keep record of their blood pressure measurement in their logbook and joined their support group to measure their blood pressure during the maintenance phase.

Statistical analysis

IBM Statistical Package for the Social Sciences (SPSS) version 22.0 (IBM Corporation, Endicott, NY, USA) was used for all analyses. The primary analysis included the participants who had taken part in the baseline, 6-month, and 12-month data collections. Any missing data were replaced using an imputation method. Descriptive analysis was conducted on the demographic data. Analysis of covariance (ANCOVA) was used to examine changes in systolic and diastolic blood pressures, dietary intake, and anthropometric and clinical parameters, controlling for confounders such as age and reported physical activity. A *p*-value of less than 0.05 was considered as statistically significant.

Results

From 163 participants initially enrolled for baseline data collection, we excluded subjects with a calorie intake of less than 800 kcal per day (men) and 600 kcal per day (women) or more than 4200 kcal per day (men) and 3500 kcal per day (women) as these reported calorie intakes seemed doubtful.³⁴ This left

Table 1. Demographic characteristics of the participants at baseline.

Variable		Baseline (<i>n</i> = 153)
Gender, <i>n</i> (%)	Male	58 (37.9)
	Female	95 (62.1)
Ethnicity, <i>n</i> (%)	Malay	141 (92.2)
	Indian	10 (6.5)
	Other	2 (1.3)
Age group, years (%)	18–29	5 (3.3)
	30–39	10 (6.5)
	40–49	37 (24.2)
	50–59	49 (32.0)
	60–69	39 (24.5)
	70–89	13 (8.5)
Mean age ± SD (years)		54.24 ± 12.27
BMI, <i>n</i> (%)	<18.5 (underweight)	4 (2.6)
	18.5–22.9 (normal)	19 (12.4)
	23.0–24.9 (overweight at risk)	20 (13.1)
	25.0–29.9 (obese I)	57 (37.3)
	≥30.0 (obese II)	52 (34.0)
Body fat (%)	Normal/lean	9.9
	Overweight	21.7
	Obese	68.4
Reported physical activity level (%)	Low	19.2
	Moderate	25.0
	High	55.8

BMI: body mass index; SD: standard deviation.

153 eligible participants at the baseline data collection point. At the end of 12-month data collection point, 63 of those participants were dropped due to non-attendance during the data collection period. Therefore, the total sample size after 12 months of intervention was 90 participants. Thus, the follow-up rate was 58.8% which is considered acceptable for an intervention study.^{35,36} Significant value was set at $p = 0.05$.

The baseline demographic characteristics of the participants are reported in Table 1. The average age of the participants was 54.24 years (± 12.27). Most of the participants were overweight (36.6%), followed by obese type I (34.4%). As for body fat, most of the participants were in the obese category (68.4%). Out of the 153 participants, 62.1% were women. The reported physical activity level shows that the more than half of the participants had a high level of physical activity (55.8%).

Table 2 shows changes in the dietary intake between the baseline, 6-month, and 12-month follow-up. The dietary changes were analyzed using repeated ANCOVA controlling for age and reported physical activity. The results revealed that there was a significant decrease in the intakes of energy, protein, carbohydrate, fat, polyunsaturated fatty acid (PUFA), sodium, and potassium during the interventional period. Sodium intake had reduced significantly by the end of the intervention period ($F = 5.24, p = 0.02$).

There were no significant changes in the mean values of both the systolic and diastolic blood pressures after controlling

for the age, weight, and reported physical activity of the participants ($(F = 0.37, p = 0.70)$ and $(F = 0.32, p = 0.72)$, respectively) (see Table 3).

There were no significant changes in the weight, waist circumference, and hip circumference of the female and male participants despite controlling for age and reported physical activity. There was significant reduction of energy intake after the end of intervention in obese participants (data not shown). Body fat percentage recorded an increasing trend in male participants (Table 4).

The related biochemical parameter changes are shown in Table 5. All the variables were analyzed by controlling for age, energy intake, and reported physical activity. The results indicated that the amount of fasting blood sugar had significantly reduced by the end of the 12-month intervention ($p = 0.01$). The amount of renal sodium at 12 months was also significantly lower ($p < 0.01$). This result correlates with the low intake of sodium shown in Table 3. Other biochemical parameters such as triglyceride, high-density lipoprotein (HDL), and low-density lipoprotein (LDL) were improved significantly after controlling for confounders.

Discussion

This intervention study focused on nutrition management as a lifestyle modification. This modification was selected in

Table 2. Dietary changes from baseline to 12-month intervention ($n = 90$).

Nutrients	Baseline, mean (95% CI)	6 months, mean (95% CI)	12 months, mean (95% CI)	<i>p</i> -value
Energy intake (kcal)	1509.19 (1413.63–1604.76)	1343.07 (1271.76–1414.38)	1327.13 (1247.44–1406.81)	<0.05
Protein (g)	60.08 (56.14–64.01)	51.66 (49.19–54.12)	50.11 (47.09–53.13)	<0.05
Carbohydrate (g)	215.07 (199.63–230.52)	202.58 (190.55–214.62)	192.94 (179.11–206.78)	<0.05
Fat (g)	46.00 (42.35–49.66)	36.44 (33.96–38.91)	39.43 (36.51–42.35)	<0.05
Cholesterol (mg)	138.90 (119.98–157.82)	123.50 (109.78–137.22)	116.89 (101.55–132.23)	NS
SFA (g)	6.90 (5.93–7.87)	6.45 (5.56–7.34)	6.37 (5.50–7.25)	NS
MUFA (g)	4.78 (4.18–5.38)	4.27 (3.83–4.70)	4.61 (4.11–5.11)	NS
PUFA (g)	3.71 (3.20–4.22)	2.91 (2.56–3.25)	3.14 (2.78–3.50)	<0.05
Sodium (mg)	2540.85 (2297.63–2784.07)	2261.00 (2085.34–2436.66)	1865.79 (1677.64–2053.94)	<0.05
Potassium (mg)	1264.40 (1141.84–1386.96)	998.41 (924.21–1072.62)	990.83 (909.00–1072.65)	<0.05
Dietary fiber (g)	3.41 (3.03–3.79)	3.56 (3.15–3.98)	4.15 (3.55–4.76)	NS
Sugar (g)	30.82 (26.18–35.47)	27.82 (23.96–31.68)	26.27 (22.55–30.00)	NS

CI: confidence interval; SFA: saturated fatty acid; MUFA: monounsaturated fatty acid; PUFA: polyunsaturated fatty acid; NS: non-significant. Mean values (95% confidence intervals) were presented. *p*-values were obtained from ANCOVA with the Bonferroni post hoc testing. Values are adjusted for age and reported physical activity.

Table 3. Change in the mean blood pressure from baseline to 12 months ($n = 90$).

Variables	Baseline (95% CI)	6 months (95% CI)	12 months (95% CI)	<i>p</i> -value
Blood pressure				
Systolic blood pressure (mm Hg)	145.49 (140.45–150.54)	142.43 (137.27–147.58)	142.55 (138.18–146.92)	NS
Diastolic blood pressure (mm Hg)	80.47 (77.93–83.01)	80.84 (78.26–83.42)	81.62 (79.20–84.05)	NS

CI: confidence interval; NS: non-significant. Mean values (95% confidence intervals) were presented. *p*-values were obtained from ANCOVA with the Bonferroni post hoc testing. Values are adjusted for age, weight, and reported physical activity.

order to try to manage the hypertension and blood pressure of the participants. Knowledge of hypertension management, emphasis on a healthy lifestyle, and self-authority and empowerment in relation to health management may help hypertension patients to comply with lifestyle changing behavior and manage their hypertension.⁷ The implementation of a lifestyle modification program has been predicted to be more economically beneficial than other strategies in combating and managing hypertension, especially in urban populations in middle- and low-income countries.³⁷ Furthermore, a lifestyle and dietary modification program that covers issues—such as reducing sodium intake and increasing the level of physical activity—can be tailored to patients' needs in order to achieve the SDG of reducing mortality due to NCDs by one-third by 2030. Such programs are more cost-effective; therefore, they can be used in many countries regardless of the economic situation.³⁸

In our study, healthy dietary intake was advised and taught to the participants during the health coaching during active intervention phase. The DASH diet was used as the guidelines of dietary and cooking modification for the participants, as this diet can help manage hypertension by emphasizing the intake of foods such as fruits and vegetables, nuts, whole grains and low-fat food, with modest intake of protein and limiting the intake of foods that are high in saturated fat, salt

and refined sugar.^{39,40} During the active intervention, the participants were encouraged to modify their usual dietary intake towards healthier option, including changing cooking styles, without advising any unnecessary supplementation of food that they cannot afford. After 12 months of intervention (active and maintenance phases), intakes of energy, protein, carbohydrate, fat, cholesterol, PUFA, sodium, potassium, and iron showed a significant reduction. The PUFA, potassium, and iron intakes probably reduced due to lessened intake of food.⁴¹ The DASH diet also encouraged participants to take canola oil, soybean oil, and nuts such as walnuts as it is also a good source of PUFA and monounsaturated fatty acid (MUFA).³⁹ However, based on the dietary assessment intake, there were not much changes in intake of food that is high in PUFA and MUFA. This is probably due to food price which the low income cannot afford to spend.⁴² Change in saturated fatty acid (SFA) was associated with reduction of weight.⁴³ However, the SFA and weight show no significant reduction in this study, probably due to the type of the whole food consumed was generally the same with some changes based on their dietary assessment.⁴⁴

During the study period, reducing salt intake (e.g., soy sauce, added salt in the cooking, flavour enhancers) was one of the main components in the lifestyle modification intervention. The recommendation was to limit salt intake to 5 g

Table 4. Anthropometric changes from baseline to 12 months.

Anthropometric measurements	Baseline, mean (CI)		6 months, mean (CI)		12 months, mean (CI)		p-value	6 months, mean (CI)		12 months, mean (CI)		p-value
	Male (n = 30)	Female (n = 30)	Male (n = 30)	Female (n = 30)	Male (n = 30)	Female (n = 30)		Male (n = 60)	Female (n = 60)	Male (n = 60)	Female (n = 60)	
Weight (kg)	70.38 (65.71–75.06)	71.79 (67.35–76.23)	71.55 (67.31–75.80)	68.12 (65.35–70.89)	68.34 (65.62–71.05)	68.38 (65.62–71.15)	NS	68.34 (65.62–71.05)	68.38 (65.62–71.15)	68.38 (65.62–71.15)	68.38 (65.62–71.15)	NS
Waist circumference (cm)	90.47 (85.82–95.12)	91.78 (88.38–95.19)	91.09 (87.30–94.89)	89.35 (85.36–93.34)	91.42 (88.66–94.19)	89.51 (86.66–92.37)	NS	91.42 (88.66–94.19)	89.51 (86.66–92.37)	89.51 (86.66–92.37)	89.51 (86.66–92.37)	NS
Hip circumference (cm)	98.63 (93.85–103.40)	99.78 (96.63–102.93)	98.34 (95.62–101.07)	104.85 (102.16–107.54)	104.78 (102.20–107.36)	103.42 (100.63–106.20)	NS	104.78 (102.20–107.36)	103.42 (100.63–106.20)	103.42 (100.63–106.20)	103.42 (100.63–106.20)	NS
Body fat (%)	23.71 (21.58–25.84)	24.48 (22.37–26.60)	24.57 (22.42–26.72)	40.97 (39.55–42.39)	41.32 (40.00–42.64)	41.07 (39.67–42.48)	NS	41.32 (40.00–42.64)	41.07 (39.67–42.48)	41.07 (39.67–42.48)	41.07 (39.67–42.48)	NS
Body mass index (kg/m ²)	25.81 (24.18–27.43)	26.30 (24.77–27.83)	26.24 (24.78–27.70)	29.10 (28.0–30.18)	29.22 (28.14–30.30)	29.30 (28.19–30.41)	NS	29.22 (28.14–30.30)	29.30 (28.19–30.41)	29.30 (28.19–30.41)	29.30 (28.19–30.41)	NS

CI: confidence interval; NS: non-significant. Mean values (95% confidence intervals) were presented. Tested with ANCOVA within groups. Values are adjusted for age and reported physical activity.

per day (3 mg sodium).⁴⁵ By the end of the intervention program, the sodium intake was reduced significantly based on the 7-day dietary histories taken at baseline, 6 months, and 12 months. This result is in line with the renal sodium parameter result which showed a significant reduction. Salt reduction is not only known to lower blood pressure but also has an effect on lowering or delaying cardiovascular morbidity and mortality in hypertensive patients.⁴⁶ Based on this study, salt reduction can reduce systolic blood pressure when we control for confounding factors such as the physical activity of the participant. In a previous study, a reduction of 30%–40% of salt intake has been shown to lower blood pressure and altogether help to control blood pressure better with less medication.⁴⁷ In Malaysia, salt reduction strategy implementation in Malaysia has been started since 2010. Among the strategies were to make sodium labeling a mandatory and negotiating with food and beverage industries to reformulate their product in order to reduce sodium content.⁴⁸ The findings of this study hopefully may encourage local food industries to play a positive role in improving the health of the nation and in achieving the SDG, by minimizing salt usage in processed foods or by introducing food products with less salt in order to reduce the incidence of NCDs in Malaysia.

Based on the significant improvement of their nutrients intake, the participants of this study probably took on board some of the guidance and information from the health and dietary coaching sessions they have attended over the 6-month active intervention period and applied it when cooking or choosing foods. Empowering the participants with knowledge on how to control their blood pressure and on healthy dietary practices may also have helped them to gain some sort of power over their own health. Therefore, this kind of power later may encourage them to follow the intervention in order to modify their lifestyle behavior.

In this study, peer-supported home blood pressure self-monitoring was part of the three-pronged interventional strategy. Teaching hypertension patients how to measure their own blood pressure may help in improving blood pressure management. Also, incorporating blood pressure self-monitoring together with other types of intervention can result in a statistically significant improvement in blood pressure, even up at the 12-month follow-up point.⁴⁹ In this study, a reduction of 2.96 mm Hg in systolic blood pressure (controlling for physical activity) was correlated with another study which shows an estimated reduction of 2–8 mm Hg when following the sodium restriction alone.⁵⁰ However, the blood pressure did not show significant reduction in this study. This was probably due to no significant reduction of weight among the participants.⁵¹

From this study, it shows that lifestyle and dietary modification can be applied even in this low-income urban community. Using healthy coaching session supported with peer-support self-blood pressure monitoring did help the participants to change their behavior and management of their hypertension. Besides, by teaching the participants on how to

Table 5. Biochemical parameter changes from baseline to 12 months ($n = 90$).

Clinical variables	Baseline, mean (95% CI)	6 months, mean (95% CI)	12 months, mean (95% CI)	p -value
Fasting blood sugar	7.30 (6.51–8.09)	6.54 (5.89–7.19)	6.92 (6.11–7.73)	<0.05
Renal sodium (mmol/L)	140.59 (139.58–141.61)	136.88 (134.64–139.12)	140.06 (139.59–140.52)	<0.05
Triglyceride (mmol/L)	1.82 (1.65–1.99)	1.83 (1.63–2.02)	1.59 (1.43–1.74)	<0.05
Total cholesterol (mmol/L)	5.44 (5.20–5.69)	5.34 (5.09–5.60)	5.29 (5.03–5.56)	NS
HDL (mmol/L)	1.16 (1.11–1.22)	1.21 (1.16–1.26)	1.33 (1.28–1.39)	<0.05
LDL (mmol/L)	3.47 (3.24–3.70)	3.33 (3.09–3.49)	3.26 (3.03–3.49)	<0.05

CI: confidence interval; NS: non-significant; HDL: high-density lipoprotein; LDL: low-density lipoprotein.

Mean values (95% confidence intervals) were presented. p -values were obtained from ANCOVA with the Bonferroni post hoc testing. Values are adjusted for age, energy intake, and reported physical activity.

self-monitor their blood pressure at home, it showed positive feedback from them. They learned to manage their blood pressure and have more authority in managing their own health. This finding is supported by a study using education package to manage hypertension in low-income community.⁵² Teaching patients on how to monitor their blood pressure at home and empowered them with education on hypertension management via phone had shown reduction in systolic blood pressure.⁵² In this study, we also see significant reduction of fasting blood glucose and renal sodium during the intervention. Printed materials containing education on blood pressure control, exercise, and recipes suitable for hypertensive patients also provided. Providing education pamphlets as part of lifestyle changing program has been showed to help improving lifestyle and control risk of NCDs.^{10,53} These show that modifying the lifestyle behaviors of the subjects, including their dietary and sodium intakes, has shown being beneficial to the participants.

Strength and limitations

To our knowledge, this study is currently the only evidence published regarding hypertension management through the combination of lifestyle modifications and home blood pressure monitoring as a strategy of empowering low-income hypertension patients living in urban setting in Malaysia. This study may therefore pave the way to further insights into the situation in and the challenges of conducting a community-based intervention in other low-income urban settlements in the country. This study also incorporated community collaboration by setting up peer-support groups and providing healthy coaching sessions to each group. This helped to nurture motivation and provide a support system in order to empower the participants and help them to modify their lifestyle behaviors. In this study, 7-day diet history was used as a method to assess nutritional intake of the participants. Using diet history can capture time of food consumption, helping the participants to remember what they eat according to breakfast, lunch, dinner, tea, and supper, and provide accurate estimation of dietary intake compared to other methods.²⁶ Moreover, in this study, we provided dedicated coaching sessions by healthcare professionals. The results

indicate that this approach was beneficial and shows that it may be helpful for healthcare professionals to be more closely involved with communities in the future.

It should be noted that there are some limitations to this study. First, this study has no control group, so comparisons could not be made. Second, we did not take a urine sodium measurement or conduct an anti-diuretic hormone test because we did not want to overburden the participants with a lot of assessments particularly as most of them were aged 50 years and above (mean age 54 ± 12 years).

Conclusion

This is the first study of using dietary modifications to improve the health of a low-income urban population in Malaysia. The combination of healthy lifestyle modifications which includes incorporating healthy cooking, modification of recipes (such as to increase fiber intake and reducing salt in cooking), and peer-supported home blood pressure monitoring has shown the benefits to improve nutritional and biochemical profiles of hypertensive patients in a low-income urban community. Close monitoring of peer-led support group with dietary modification has the potential to be applied to control and reduce blood pressure in hypertensive patients. Further larger scale studies are required to confirm this finding.

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Author contributions

A.N.A., M.H.A., S.T.T., and A.N.M. contribute substantially to the conception and design of this study. A.N.A. was responsible for data acquisition, analyzing, interpretation of the data, and drafting the article. M.H.A. and S.T.T. were responsible for reviewing and editing of the article. All authors were responsible for approval of the final manuscript.

Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Ethical consideration

Ethical approval for this study was obtained from the Medical Ethics Committee, University Malaya Medical Centre (reference no. 944.18) and conducted in accordance with the Declaration of Helsinki requirements.

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Informed consent

Written informed consent was obtained from all subjects before the study.

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Supplemental material

Supplemental material (Questionnaire for the study) for this article is available online.

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