ORIGINAL ARTICLE

Role of sodium-restricted dietary approaches to control blood pressure in Pakistani hypertensive population

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Abstract

Objective: To assess the change in systolic and diastolic blood pressure in post-interventional phase through \dietary approaches to stop hypertension/salt-restricted diet.

Methods: This randomised controlled clinical study was conducted from February 2014 to March 2015 at the Armed Forces Institute of Cardiology, Rawalpindi, and Ali Medical Centre, Islamabad, Pakistan, and involved hypertensive patients and matching controls. The control group followed routine diet while the intervention group was given a diet plan containing 1,500mg of sodium providing 2,000 calories. Both groups were advised not to consume sodium-rich foods. Paired sample t-test was applied to determine the change in blood pressure among the groups at two different occasions.

Results: Of the 1,492 participants, 710(47.6%) were controls and 782(52.4%) were in the interventional group. Overall, 417(27.9%) participants got their blood pressure checked less than twice in six months, while 409(27.4%) had it done on a regular basis. Moreover, 941(63.1%)) subjects had a family history of high blood pressure and 149(10.0%) participants did not exercise at all. The overall mean age was 53.42±9.302 years. Mean systolic blood pressure and diastolic blood pressure after five weeks was 126.33±3.35 and 84.40±3.04mmHg in the intervention group, and128.41±3.52 and 84.04±2.953mmHg in the control group. Changes in blood pressure between the two groups were minimal but statistically significant ($p<0.05$).

Conclusion: A diet which is restricted in salt, rich in fruits, vegetables, and low-fat dairy foods and reduced saturated and total fat can substantially lower blood pressure. Such a diet offers an additional nutritional approach to the prevention and treatment of hypertension.

Keywords: DASH/SRD, Hypertension, Sodium-restricted. (JPMA 66: 837; 2016)

Introduction

High blood pressure (BP) is estimated to cause 7.5 million deaths worldwide while hypertension (HT) is a leading risk factor for heart disease and stroke, and affects about 25.2% percent of adults in Pakistan.[1,2] Latest version of the Joint National Committee (JNC) guidelines continues to define high BP as 140/90 mmHg; it aims to redefine the goals and thresholds for pharmacological treatment and the selection of antihypertensive drugs.[3] Unlike JNC 7 guidelines, JNC 8 guidelines do not focus on the definition of HT and pre-HT. A strong recommendation is made to start pharmacological treatment to lower BP to less than 150/90mmHg in hypertensive patients aged 60 or older and to a diastolic goal of less than 90 mm Hg in hypertensive patients aged 30 to 59.[3] High BP can lead to heart attack, stroke, kidney disease, eye diseases and metabolic syndrome.[4]

Dietary factors may have an important role in BP homeostasis. In hypertensive individuals, dietary changes that lower BP have the potential to prevent HT and, more broadly, to reduce BP, thereby lowering the risk of BP-related clinical complications. Among hypertensive individuals who are already on drug therapy, dietary changes, particularly a reduced salt intake, can further lower BP and facilitate medication step-down.

Dietary Approaches to Stop Hypertension (DASH) is gold standard in dietary recommendation by the American Society of Hypertension (ASH).[5] The standard DASH diet daily intake of sodium is up to 2.3g (5.75g) while salt-restrictive DASH diet daily intake of sodium is up to 1.5g.[6,7] It is a well-known fact that increased salt consumption raises BP and vice versa,[8,9] A meta-analysis done on 167 studies concluded that sodium reduction resulted in 1% decrease in BP in normotensives and 3.5% decrease in BP in HT patient.[10] The current study was planned to assess the change in systolic (SBP) and diastolic blood pressure (DBP) in the post-interventional phase through the consumption of a controlled diet.

Patients and Methods

This randomised controlled clinical study was conducted

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from February 2014 to March 2015 at the Armed Forces Institute of Cardiology, Rawalpindi, and Ali Medical Centre, Islamabad, Pakistan, and comprised HT patients. A two-stage sampling was employed. During the first stage, a simple random sampling procedure was used to select the hospitals. This was done to allow an equal chance for every hospital to be included. For this, a list of all the hospitals attended by low-, middle- and high-income groups in the twin cities of Rawalpindi and Islamabad was prepared. A sampling frame was prepared from this list. Finally, the sampling units were selected through computer-generated table of random numbers in order to ensure equal participation; and to generalise the results to all adult HT patients of middle- and high socio-economic group.

Diagnosed adult HT patientswhowere on one of the three anti-hypertensive drugs, losartan potassium, amlodipine besylate, nifedipine, and whose SBP was between 110-140 mm Hg and DBP between 70-90 mm Hg were included. Controlled HT subjects with BP$\leq$140 / 90 mm Hg were included in order to have a standardised internally homogenised sample in which the effect of diet could be studied. This facilitated greater compliance of the subjects and avoided major fluctuation in BP leading to emergency situation, hence loss to attrition. Diagnosed adult HT patients who were on multi-drug therapy for control of HT or whose BP was > 140 / 90 mm of Hg, smokers or who had evidence of any other disease were excluded. Stage 2 of the sampling included selection of the participants through the outpatient department (OPD) of these hospitals based on convenience sampling (Figure).

Consent was taken from the subjects, after which an interview was conducted by the researcher to record information on a self-designed questionnaire. To achieve the desired objective, data collection instrument was divided into two parts. Part - A consisted of information in the pre-interventional phase and was divided into 11 sections. These included information on demographic profile, personal medical history, family history, lifestyle, type of food they ate on a regular basis, portion size, snacking habits, timings of meal, salt content of their meals, frequency of meal, BP readings, anthropometric measurements, self-assessment, status of the interview and sample collection. Part -B consisted of information in the post-interventional phase, which was designed to collect data on BP and lipid profile. The same questionnaire was used in Part-B. The questionnaire was developed based on eating habits of Pakistani population, keeping in view religious and cultural norms. Pre-testing of the questionnaire was done on 50 patients who fulfilled criteria of the study but were not participants.

Anthropometric measurements were taken and recorded on the questionnaire. These included measurements of height, weight, circumference of waist and hips. Weight was measured by the investigator on a standardised weight scale measuring to the nearest 0.5 kilograms. The zeroing of the scale was carried out before each session. Height of the subjects was measured in a standard way. Two observers measured the height on a standard scale. One observer maintained the position of the subject while the other maintained it to the nearest 0.5cm mark. Measuring tape was used to take the waist and hip circumference. The reference point for measuring the waist circumference was taken at 14 inches below the tip of shoulder. The hip measurement was taken at the widest diameter around the hips. BP was recorded on both the arms in the sitting position with the help of mercury sphygmomanometer. The arm which gave the higher value was used as the reference for the next reading. First recording of BP was done while the patients were waiting to see the doctor. After the patient had consulted the doctor, BP reading was again taken on the reference arm. There was an interval of 30 minutes to 2 hours between the two readings. The mean of these readings was recorded for every participant. BP was recorded through the same procedure in the post-interventional phase.

Patients who were eligible for the study were then referred to the dietician. The participants were then matched according to the gender, age, monthly family income, educational level, frequency of exercise, SBP and DBP. Case matching was done at this step. The patients were randomly allocated to the control and interventional group. In cases where the participants did not give consent to follow the diet plan, the immediate next study member was assigned the task. The diet plan was not individualised. The participants were divided into two groups: control group and interventional group. The drop-outs were large among the intervention group due to difficulty in following the diet plan. The control group followed routine diet while the intervention group was given a diet plan containing 1,500mg of sodium providing 2,000 calories to be followed over a period of five weeks (Annexure). Food composition table[10] was used to calculate the sodium content and caloric content. Participants from both groups were advised to make a daily food diary. They had to submit it to the centre concerned on a weekly basis. BP and serum cholesterol, high-density lipoprotein (HDL) and low-density lipoprotein (LDL), were again recorded in the post-interventional phase for both the groups. The costs of

Annexure: Salt-restricted diet plan for individuals with high blood pressure.

	Calories (kcal)	Sodium (mg)
Early morning		
◆ Fresh fruit Juice ½ cup / whole fruit: 1	45 / 60	2 / 2
(Peach: 1/ apple: 1/ plums: 2/ apricots: 2/ banana: ½ /grapes:13)		
Breakfast		
◆ Bread : 2 slice	200	220
◆ Unsweetened Corn flakes / cereal : ½ cup	120	100
◆ Milk low fat : 1 cup	120	100
◆ Egg white : 1	45	55
◆ Diet jam / Honey : 1 tsp	170	2
Mid- day Snack		
◆ Tea / Khawa	120 /	60 /
◆ Biscuit: 1	40	64
Lunch		
◆ Chapatti: 1 / Rice: 1/3 cup	80	65 / Trace
◆ Cooked pulses: ½ cup /	80 /	Trace /
*Chicken curry (leg & thigh) 3 oz	90	90
◆ Cooked vegetable: ½ cup	80	15
◆ Raw fresh vegetables: 1 cup	25	12 (average)
◆ Yogurt: ½ cup	100	164
◆ Fruit	60	2
(Peach: 1/ apple: 1/ plums: 2/ apricots: 2/ banana: ½ /grapes:13)		
Mid-evening Snack		
◆ Milk / tea: 1 cup	120	120
◆ Rusk: 1	80	100
Dinner		
◆ Chapatti: 2 / Rice 2/3 cup / Pasta 1 cup	160	4 / 0 / 0
◆ Cooked pulses: ½ cup	80	Trace
◆ Cooked vegetable: ½ cup	80	50
◆ Raw fresh vegetables: 1 cup	25	12 (average)
◆ Yogurt: ½ cup	100	164
◆ Fruit	60	2
(Peach: 1/ apple: 1/plums: 2/ apricots:2 /banana: ½ / grapes:13)		
Night		
◆ Milk: ½ cup	60	60
Total calories: 2000 kcal	**Total Sodium: 1500mg**	

*Chicken curry to be consumed on alternate days only.

tests were borne by the participants themselves or the hospital in case of entitled patients.

Telephonic contact of the participants with the researcher was provided in case of any concern regarding the diet plan or the study.

The diet plan was prepared keeping in view the eating habits, likes and dislikes of Pakistani population. Our diet plan is based on DASH salt-restricted diet (SRD)[10] (Table-1). Ethical approval of the study was taken from the participating institutions.

SPSS 21 was used for data analysis. Relevant descriptive statistics including means, ranges, standard deviation and frequency of occurrence were calculated. Independent t-test was done to see if there was statistically significant difference ($p<0.05$) in SBP, DBP, lipid profile while matching for body mass index (BMI) and age. Paired-sample t-test was done to see if there was a significant difference ($p<0.05$) in BP and lipid profile of the two groups after a period of 5 weeks.

Results

Of the 1,700 participants, 1,492(87.8%) completed the study. Of them, 710(47.6%) were from the control group and 782(52.4%) from the interventional group (Table-2). Overall, 417(27.9%) participants got their BP checked less than twice in 6 months, 613(41.1%) not less than twice in 1 month, 409(27.4%) regularly, while 53(3.6%) frequently. Only 162(10.9%) participants maintained a regular record of BP checked regularly while the remaining 1,330(89.1%) did not. Moreover, 1,144(76.7%) had an instrument for recording blood pressure, of which 601(40.3%) had a digital and 543(36.4%) had a manual device. Further, 941(63.1%), subjects had a family history of high BP; 616(41.3%) had a sibling suffering from high BP; 209(14.0%) drank alcohol; and 432(29.0%) smoked.

Of the total, 149(10%) participants did not exercise at all, while 454(30.4%) exercised once a month, 216(14.5%)

Table-1: Daily Nutrient Goals used in salt-reductive DASH.

Total fat	27% of calories
Saturated fat	6% of calories
Protein	18% of calories
Carbohydrate	55% of calories
Cholesterol	150 mg
Sodium	1500 mg
Potassium	4,700 mg
Calcium	1,250 mg
Magnesium	500 mg
Fiber	30 g

DASH: Dietary Approaches to Stop Hypertension.

Table-2: Demographic Profile of Control and Interventional Groups.

Demographic Variables	Control Group (n= 782)	Interventional Group (n=710)
Age(years)	52.32±9.110	54.41±9.367
Male	369(47%)	392(55%)
Female	341(53%)	390(45%)
Mean Duration of Hypertension (years)	3.61±1.201	3.74±1.197
BMI (kg/m^2)	27.900±3.592	27.224±3.439
Mean Duration of exercise (mins)	26.34±3.575	25.21±3.781

BMI: Body mass index.

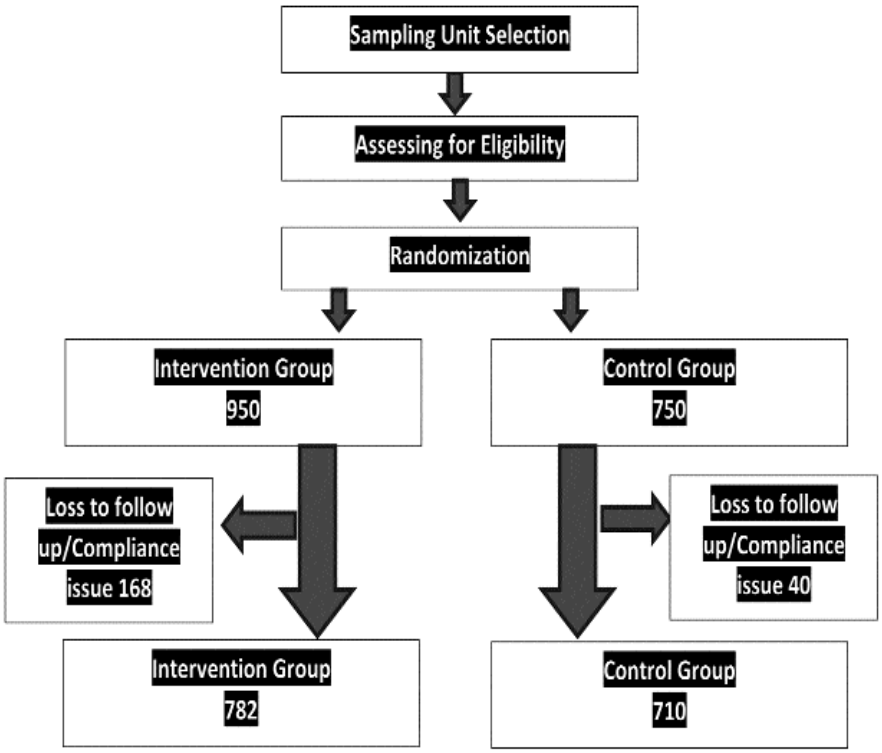

Figure: Flow chart showing the Eligibility, Randomisation and Follow-up.

once a week, 216(14.5%) thrice a week and 448(30.0%) on a regular basis. Besides, 999(67.0%) graded their lifestyle as sedentary, while 471(31.6%) and 22(1.5%) as active and very active, respectively. It was found that 603(40.4%) participants ate snacks more than two times a week, while 923(61.9%) restricted salt in their diet. Overall, 840(56.3%) thought their BP was adequately maintained. All of the participants thought that ideal BP is 120/80 and 903(60.5%) considered themselves healthy.

Changes in SBP between the two groups were minimal, but statistically significant ($p<0.05$). It increased by 0.2 mmHg in the control group, while decreased by 2.19 mmHg in the interventional group (Tables-3 and 4).

Discussion

Direct causal relationship between the level of salt intake and BP in population level is also

Table-3: Blood Pressure and Lipid Profile in Control Group.

	Visit 1 (baseline) Mean ± SD	Visit 2 Mean ± SD	Difference Mean ± SD	p-value
Systolic Blood pressure	128.21 (3.797)	128.41 (3.525)	(-)0.197(1.801)	0.004
Diastolic Blood pressure	84.20 (3.281)	84.04 (2.953)	0.155(1.175)	0
Serum Cholesterol	209.02 (24.909)	209.02 (22.832)	(-)0.179(6.119)	0.436
Serum HDL	45.96 (11.321)	45.81 (10.967)	(-)0.845(1.334)	0
Serum LDL	115.86 (36.021)	114.92 (34.534)	0.942(10.391)	0.016

SD: standard deviation
HDL: High-density lipoprotein
LDL: Low-density lipoprotein.

Table-4: Blood Pressure and Lipid Profile in Intervention Group.

	Visit 1 (baseline) Mean ± SD	Visit 2 Mean ± SD	Difference Mean ± SD	p-value
Systolic Blood pressure	128.52 (3.833)	126.33 (3.356)	2.197(0.915)	0
Diastolic Blood pressure	84.52 (3.260)	84.40 (3.049)	0.118(0.551)	0
Serum Cholesterol	211.64(26.816)	211.35(26.217)	0.292(1.264)	0
Serum HDL	45.25 (11.005)	45.126(10.906)	0.090(0.403)	0
Serum LDL	122.46 (33.905)	122.32 (33.755)	0.140(0.548)	0

SD: standard deviation
HDL: High-density lipoprotein
LDL: Low-density lipoprotein.

recognised.[12,13] Average daily salt intake in the world is 9-12 grams per person daily and the World Health Organisation (WHO) recommends decrease of sodium intake on <2 grams of salt per day (5g of salt per day) in adults to lower BP and cardiovascular (CV) risks, stroke and coronary disease.[14] Reduction of salt on national level presents the cheapest way of preventing cardiovascular diseases (CVD). It is estimated that the decrease of salt intake in food from usual 6g per day will be related with decrease of SBP/DBP 7/4 mmHg in those with HT and for 4/2 mmHg in those without HT.[13] Decrease of high BP can reduce the rate of stroke in 24% and coronary disease in 18%people.[15] According to recommendations of Dietary Guidelines for Americans, maximum daily intake of sodium is 2.3g (5.75g of salt) and in DASH/SRD (recommendations of American Heart Association) daily intake of sodium is 1.5g (3.75g of salt).[16,17] In only one meal eaten during work time, an employee takes in 4-9 grams of salt. High intake of salt is related to significantly increased risk of stroke and general CVD but for inaccuracy in salt intake measurement this part of efficiency will probably be underestimated.[18] Guidelines on sodium intake measures to decrease it are needed through public health interventions, including labelling of food and products along with education of consumers.[14]

Clinical research proves that decrease of sodium intake decreases BP in adults with HT and pre-HT. That step would be sufficient for prevention and progressing from pre-HT to HT and for promotion of non-pharmacological control of CV pressure in those cases with HT, and less intake of sodium is related to lower risk from CV events in those cases with and without HT.[19] It is proven that DASH diet rich in fruit, vegetables and low-fat milk products with less intake of total fat, significantly reduces BP.[20] A study concluded that use of DASH diet decreases SBP by 11.2 mmHg in tested subjects with first degree of isolated systolic HT.[21] This is a significant effect and is comparable with effect of antihypertensive medications on such patients. Recommendations of American College of Cardiology/American Heart Association (ACC/AHA) for adults are that decrease of sodium intake to up to 1.5g per day can lead to decrease of BP.[14] Trial of non-pharmacologic interventions in the elderly (TONE) study proved that decrease of salt in 1.8g per day leads to decrease of need for antihypertensive medications by 30%.[22] Trials of hypertension prevention (TOHP) studies for prevention of HT have reported that rate in CV events was 25% lower in tested group which was advised to decrease sodium intake compared to controlled tested group. It was the most convincing evidence related to limitation of sodium intake and CV risks.[23]

A randomised controlled trial done in Pakistan concluded that reducing sodium intake has a beneficial effect on BP in Indo-Asians with high-normal SBP.[24] A meta-analysis done to see effect of long-term modest salt reduction on BP found that reducing salt intake for four or more weeks causes a significant fall in BP in both hypertensive and normotensive individuals.[25]

Finally, as this study represented Pakistanis who were educated and belonged to the high socio-economic class, its results cannot be generalised to the overall population. Though the change in the SBP and DBP is significant, it is very small. Better compliance of the patients could have been achieved had we provided diet to the study participants along with the diet plan. Financial constraints were among the major limitations of our study in this regard.

As such, we recommend that a longitudinal study involving a feeding trial based on similar guidelines of eight-week duration involving a very large number of subjects should be carried out before the results can be generalised.

Conclusion

A diet which is restricted in salt, rich in fruits, vegetables, and low-fat dairy foods and reduced saturated and total fat can substantially lower BP. Such a diet offers an additional nutritional approach to the prevention and treatment of HT. This along with lifestyle changes, like adequate physical activity, can not only improve the BP levels but also improve the quality as well as length of life in HT patients.

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