Original Article

Dietary Pattern and Blood Pressure Control in a Hypertension Outpatient Clinic

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Although it is well known that some dietary measures are able to beneficially affect blood pressure (BP) levels, hypertensive patients find it very difficult to definitively change their nutritional habits. The aim of this study was to evaluate the effects on BP of a return to the habitual diet following a dietary intervention period. Three hundred and seven hypertensive patients (149 females, 158 males) with a mean age of 52 ± 12 years were included in the study. All enrolled patients had reported having reverted to their habitual diet after a period of at least 6 months on a prescribed low-energy and/or low-sodium diet. Nutritional habits were investigated by a simple semiquantitative 24-item food-frequency questionnaire. Patients were divided into tertiles according to their systolic BP. The groups differed in regard to their body mass index (27.6 ± 4 , 28.7 ± 4 , and 30.4 ± 6 kg/m², respectively, for the low- to high-systolic BP groups, but were similar in regard to the number of antihypertensive pills taken (2.1 ± 0.9 , 2.2 ± 1.2 , 2.2 ± 1.3) and metabolic parameters. Patients in the lowest tertile consumed a diet significantly lower in the percentage of energy from saturated fats and sodium content and significantly higher in the percentage of energy from carbohydrate, and the fiber and potassium content in comparison to the highest tertile. The number of servings of legumes, fish and cooked vegetables was higher and that of salami and cheese lower in the 1st tertile. Definitively changing a habitual diet to a healthier one is a difficult task for hypertensive patients. However, those who return to a diet richer in vegetables, legumes and fish and poorer in saturated fat and salt achieve better control of their BP, without increasing the number of antihypertensive pills. (*Hypertens Res* 2007; 30: 1043–1050)

Key Words: hypertension, obesity, dietary pattern, dietary questionnaire, saturated fats

Introduction

There is a close relationship between blood pressure (BP) levels and other metabolic abnormalities, such as overweight or frank obesity particularly visceral obesity (1, 2), hyperglycemia or diabetes (3, 4), dyslipidemia, due to high triglycerides and low high-density lipoprotein (HDL)-cholesterol levels (5, 6). The clustering of three or more of these abnormalities is referred to as metabolic syndrome (7, 8), which carries an increased risk of cardiovascular diseases (9, 10). The main purpose of antihypertensive treatment is to achieve the maxi-

mum reduction in the long-term total risk of cardiovascular morbidity and mortality by treating all the reversible risk factors identified (11). In this regard, lifestyle measures are particularly important in patients with arterial hypertension in order to control not only BP but also other risk factors and clinical conditions that eventually develop. Of the different measures that have been proposed, only some are suggested by the guidelines to effectively lower BP levels (11, 12): weight loss in order to reduce and maintain body mass index (BMI) < 25 kg/m² (13), reduced salt intake (approximately 4.0 g/day of sodium chloride) (14), increased potassium intake (approximately 4.7 g/day) (15), increased intake of

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Table 1. Mean Energy and Nutrient Composition of the Diets Prescribed to Hypertensive Patients at the Entry in the Outpatient Clinic, According to Their Body Mass Index

	Severe hypocaloric diet (48 M, 62 F)	Moderate hypocaloric diet (42 M, 33 F)	Normocaloric diet (68 M, 54 F)
Energy, kJ	4,468	6,481	9,138
kcal	1,068	1,549	2,184
Carbohydrates, g (% energy)	133 (47)	217 (53)	307 (53)
Proteins, g (% energy)	65 (24)	70 (18)	83 (15)
Lipids, g (% energy)	35 (29)	50 (29)	78 (32)
PUFA, g (% energy)	4 (3.5)	4.8 (3)	7 (3)
MUFA, g (% energy)	23 (18.5)	32.2 (19)	55 (23)
Saturated fats, g (% energy)	8 (7)	13 (7)	16 (6)
Cholesterol, mg	182	172	172
Fibers, g	36	40	49
Sodium chloride, g	1.95	2.57	3.8
Potassium, g	3.82	3.89	4.20

M, male; F, female; PUFA, polyunsaturated fatty acid; MUFA, monounsaturated fatty acid.

fruit and vegetables and reduced intake of saturated fat and cholesterol (16), and moderate alcohol intake (17). Some studies have also reported that increased intake of monounsaturated (18, 19) and polyunsaturated (20) fatty acids, as well as supplementation with fish oil (21), fiber (22), calcium (23) and magnesium (24), significantly affected BP levels, but these effects have not been observed consistently in all studies.

This study was prospectively designed to evaluate the long-term effects (at least 2 years) of a low-sodium and/or low-energy diet on BP control and their interaction with antihypertensive drugs. The design included two phases: in the first one, the intensive diet phase, patients were prescribed a low-energy and/or low-sodium diet along with antihypertensive medications and were followed-up by doctors and dieticians at 1-month intervals for 6 months. In the second phase patients were still prescribed diet and drugs but were seen by the doctors without the dietician at 2-month intervals. Six months after starting this second phase, patients were asked to fill out a questionnaire regarding their daily food intake in order to assess their compliance to the diet. As frequently occurs with hypertensives started on such regimens (25), when the initial phase of care with weight loss was over, at approximately 6–12 months after starting, many patients reverted to their habitual diet. The present investigation focused, therefore, on the possible effects on BP levels of the return to a habitual daily diet after a period of strict compliance to a dietary regimen.

Methods

Patients

Three-hundred-seven patients (149 females, 158 males) with a mean age of 54 ± 12 years (range: 19–88 years) who were

seen regularly in the hypertension outpatient clinic of our department were entered into the study.

The inclusion criteria were: 1) Follow-up in the outpatient clinic for at least 1 year; 2) No change in the dietary prescription in the last 6 months; 3) Previous compliance to the diet with weight loss, and discontinuation of the diet in the last 6 months; 4) No change in the daily dosage of antihypertensive medications in the last 6 months; 5) No use of oral contraceptives in the last 6 months.

Upon their first visit to the outpatient clinic, all patients had received a dietary prescription to reduce their daily intake of sodium and increase that of potassium. Caloric intake had been tailored on the basis of their body mass, ranging from 1,100 kcal/day in the obese subjects to 1,500 kcal for those overweight to 2,200 kcal for patients with normal body weight (BW). Olive oil was the main source of fat and dieticians recommended that it be added to the food in a dose ranging from 2 to 5 tablespoons according to the total daily calories. The composition of these diets is shown in Table 1. All patients had been on a diet for at least 6 months (initial care program) but had discontinued it at from 3 to 6 months before inclusion in the present analysis.

Patients eligible for the study were informed of the purpose of the present investigation and their informed consent was obtained. They were asked to fill out a simple semiquantitative 24-item food-frequency questionnaire, which had been previously validated against a 7-day food record (26). This questionnaire collected data about the daily or weekly number of servings of the main food groups, from which dieticians could calculate the total calories and percentage of total energy from the different dietary components. In particular, subjects were asked to report the number of servings of carbohydrates (bread, pasta, rice), fish, eggs, milk, dairy products, fruits and vegetables, and fat and oil. Finally, they were asked about their daily working activity and lifestyle overall. Based

Table 2. Body Weight and Blood Pressure of the Hypertensive Patients before and at the End of the Intensive Care Phase, Divided in Tertiles According to SBP Measured at the Moment of the Compilation of the Dietary Questionnaire

	Group 1 (SBP ≤ 129 mmHg) (50 M, 31 F)	Group 2 (SBP > 129 and ≤ 140 mmHg) (61 M, 64 F)	Group 3 (SBP > 140 mmHg) (47 M, 54 F)
Baseline body weight, kg	80.2 ± 16	82.2 ± 16	84.2 ± 20
Body weight (intensive care), kg	75.3 ± 14	77.3 ± 15	79.7 ± 19
Baseline body mass index, kg/m ²	28.8 ± 5 ^y	29.9 ± 5 ^x	31.3 ± 7
Body mass index (intensive care), kg/m ²	27.0 ± 4 ^z	28.1 ± 4 ^x	29.6 ± 6
Baseline SBP, mmHg	153.7 ± 8.2	153.8 ± 11.0	153.3 ± 9.3
SBP (intensive care), mmHg	121.5 ± 6 ^{x,a}	122.9 ± 3	122.9 ± 3
Baseline DBP, mmHg	93.4 ± 6.3	93.0 ± 6.2	94.6 ± 7.0
DBP (intensive care), mmHg	77.5 ± 6	78.7 ± 6	79.5 ± 7
Baseline HR, beats/min	71.2 ± 5.7	70.7 ± 5.4	72.5 ± 6.5
HR (intensive care), beats/min	71.2 ± 7	70.5 ± 9	72.7 ± 10

Significances vs. group 3: ^x $p < 0.05$; ^y $p < 0.01$; ^z $p < 0.001$. Significance vs. group 2: ^a $p < 0.05$. M, male; F, female; SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate.

on their responses to items regarding their physical activity, subjects were then divided into three groups: those who were sedentary, those whose physical activity was limited to walking, and those who participated in a regular physical activity. Subjects were also asked how many times each week they walked or participated in a regular physical activity, with possible responses ranging from less than 1 h weekly to more than 4 h.

At the same visit, BP, heart rate (HR), BW, height (Ht), and waist circumference (WC) were measured; BMI was calculated as BW/Ht² (kg/m²). Type of antihypertensive drugs used and number of daily pills were also recorded, with one pill corresponding to a daily dosage of 25 mg of hydrochlorothiazide, 20 mg of lisinopril, 300 mg of irbesartan, 10 mg of amlodipine, 100 mg of atenolol, or 8 mg of doxazosin.

Thereafter patients underwent measurements of the following biochemical parameters: fasting blood glucose (FBG), serum creatinine (Cr), creatinine clearance (Cr Cl), total cholesterol (Chol), cholesterol in the high-density lipoproteins (HDL-chol), triglycerides (Tg), serum electrolytes (sodium [Na] and potassium [K]); cholesterol in the low-density lipoproteins (LDL-chol) was calculated according to the Friedewald formula (27).

Statistical Analysis

Data were analyzed by using the SPSS (SPSS-PC; SPSS Inc., Chicago, USA) statistical package. Results were expressed as the means ± SD or 95% confidence intervals (CI) as indicated. Comparisons of means were performed by Student's *t*-test for paired data and one-way analysis of variance with Tukey's multiple comparisons. Pearson linear correlation was used to detect bivariate associations between different variables. Differences between nonparametric variables were assessed by χ^2 test.

Results

At the end of the initial care program BW had decreased in all patients from 82.4 ± 18 to 77.6 ± 16 kg ($p < 0.001$) and BP from 153.6 ± 10/93.6 ± 6 to 122.5 ± 4/78.6 ± 6 mmHg ($p < 0.001$), without a change in HR (from 71.4 ± 6 to 71.9 ± 9 beats/min).

Patients were divided into tertiles according to their systolic blood pressure (SBP), measured at the end of the intensive diet period, immediately after they had completed the nutritional questionnaire. Cut-offs for the SBP tertiles were ≤ 129 mmHg for the first, > 129 and ≤ 140 mmHg for the second, and > 140 mmHg for the third. Eighty-one patients were included in the 1st tertile, 125 in the 2nd, and 101 in the 3rd.

The BP tertiles did not differ for pre-treatment BP (*i.e.* BP measured at the beginning of the intensive diet phase), but were slightly different for SBP at the end of the intensive diet phase (Table 2). At the time that the questionnaire was administered, on the other hand, the tertiles differed not only with respect to SBP and diastolic blood pressure (DBP), by definition, but also in regard to BMI (Table 3). HR did not change over the study period, according to the criterion that patients had not changed treatment before the inclusion in the study and during the observation period. No difference was detected in the main parameters of biochemistry. The rate of regular physical activity was similar among the three groups (16% of the patients in the 1st tertile, 13% in the 2nd tertile and 12% in the 3rd tertile performed regular physical activity) but walking was more frequently performed in the first tertile than the others (30% vs. 17% and 21%, respectively).

Regarding the antihypertensive drug consumption, no difference was detected among the groups: 94% of patients in the 1st, 91% in the 2nd and 92% in the 3rd tertile were on antihypertensive medications and the mean daily pill consumptions were 2.1 ± 0.9, 2.2 ± 1.2 and 2.2 ± 1.3 pills, respectively.

Table 3. Body Weight, Blood Pressure and Biochemical Parameters of the Hypertensive Patients, Divided in Tertiles According to Their SBP Measured at the Moment of the Compilation of the Dietary Questionnaire

	Group 1 (SBP≤129 mmHg) (50 M, 31 F)	Group 2 (SBP>129 and ≤140 mmHg) (61 M, 64 F)	Group 3 (SBP>140 mmHg) (47 M, 54 F)
Age, years	51.6±12 ^y	53.3±10	56.3±13
Body weight, kg	77.2±15	79.2±15	81.7±15
Body mass index, kg/m ²	27.6±4 ^z	28.7±4 ^x	30.4±6
Waist circumference, cm	95.3±11	96.4±12	99.0±14
SBP, mmHg	119.3±6 ^{z,a}	135.9±5 ^z	153.7±11
DBP, mmHg	78.3±8 ^{z,a}	85.1±8 ^z	91.4±9
HR, beats/min	70.9±7	70.1±7 ^y	72.9±9
Serum creatinine, mg/dL	0.97±0.21	0.93±0.20	0.92±0.25
Fasting blood glucose, mg/dL	96.4±18	98.7±22	99.2±26
Total cholesterol, mg/dL	190.4±36	207.3±34	205.3±43
LDL-cholesterol, mg/dL	118.1±32	132.3±30	127.8±36
HDL-cholesterol, mg/dL	47.1±9	48.3±12	48.9±14
Triglycerides, mg/dL	116.7±69	130.9±65	125.9±74
Serum sodium, mmol/L	140.7±3	140.0±4	139.7±4
Serum potassium, mmol/L	4.5±0.8	4.4±0.5	4.4±0.4

Significances vs. group 3: ^x $p<0.05$; ^y $p<0.02$; ^z $p<0.001$. Significances vs. group 2: ^a $p<0.001$. M, male; F, female; SBP, systolic blood pressure; DBP, diastolic blood pressure; HR, heart rate; LDL, low-density lipoprotein; HDL, high-density lipoprotein.

Table 4. Mean Daily Energy and Nutrient Composition of the Dietary Habits, Evaluated by the 24-Item Food Record, of Hypertensive Patients Divided in Tertiles According to Their SBP Measured at the Moment of the Compilation of the Dietary Questionnaire

	Group 1 (SBP≤129 mmHg) (50 M, 31 F)	Group 2 (SBP>129 and ≤140 mmHg) (61 M, 64 F)	Group 3 (SBP>140 mmHg) (47 M, 54 F)
Energy, kJ	7,390.6±2,326	8,031.2±2,711	8,305.2±2,925
kcal	1,766.4±556	1,919.5±648	1,985.2±699
Carbohydrates, % energy	52.7±4	51.1±4	50.4±5 ^y
Proteins, % energy	17.5±3	17.4±3	16.5±3
Lipids, % energy	25.2±2	25.9±3	27.5±3 ^x
PUFA, % energy	4.9±1.6	5.1±1.9	5.2±1.9
MUFA, % energy	13.6±2.4	13.6±2.4	13.4±3.2
Saturated fats, % energy	6.7±1.6	7.2±2.1	8.9±2.1 ^z
Cholesterol, mg/dL	178.5±89	197.3±92	210.1±101
Fibers, g	27.4±10	26.6±9	23.4±9 ^z
Sodium chloride, g	3.3±1	3.8±2	4.1±2 ^y
Potassium, g	3.5±1.1	3.5±1.0	3.1±1.0 ^y
Calcium, mg	717.1±221	740.1±240	759.3±256
Magnesium, mg	355.3±115	339.8±107	311.3±106 ^y

Significances: ^x $p<0.05$; ^y $p<0.02$; ^z $p<0.005$. SBP, systolic blood pressure; M, male; F, female; PUFA, polyunsaturated fatty acid; MUFA, monounsaturated fatty acid.

Regarding the type of drug used, no difference was detected in the consumption of β -blockers, angiotensin converting enzyme inhibitors, and calcium antagonists, while patients in the 2nd and 3rd tertile groups used diuretics and α -blockers more frequently than those of the 1st tertile group.

Most of the patients declared that they were still trying to reduce their salt and caloric intake, despite having discontinued the prescribed diet more than 3 months ago. In particular, 70% of patients in the 1st tertile were found to have reduced, at least in part, their sodium and caloric intake (51% were on

Table 5. Number of Weekly Servings, Evaluated by the 24-Item Food Record, in Hypertensive Patients Divided According to Their SBP Measured at the Moment of the Compilation of the Dietary Questionnaire

Food groups	Group 1 (SBP ≤ 129 mmHg) (50 M, 31 F)	Group 2 (SBP > 129 and ≤ 140 mmHg) (61 M, 64 F)	Group 3 (SBP > 140 mmHg) (47 M, 54 F)
Milk (cups of 200 mL)	4.9±3.4	4.9±3.0	5.1±3.2
Bread	8.7±5.9	9.0±5.5	10.3±5.1
Pasta/rice	5.2±2.1	5.3±2.4	4.9±2.5
Legumes (peas, beans, lentils)	2.2±1.2 ^z	1.9±1.1 ^y	1.4±1.2
Beef/poultry	2.9±1.4 ^a	3.5±1.6 ^y	3.0±1.5
Eggs	1.3±0.9	1.2±0.8	1.4±1.0
Fish	2.4±1.2 ^w	2.1±1.4	1.9±1.2
Cheese	2.2±2.3 ^w	2.5±2.7 ^x	3.3±2.7
Salami	1.4±2.2	1.9±2.3	2.3±2.3
Vegetables	3.1±2.8	3.1±3.0	3.1±3.0
Cooked vegetables	6.1±3.9 ^w	6.2±3.9 ^w	4.5±3.4
Fruit	11.0±4.8	11.1±5.5	11.0±5.2
Olive oil (spoons)	10.9±4.2	10.5±4.2	9.9±4.5
Wine (glasses of 125 mL)	1.3±1.4	1.0±1.3	1.1±1.4

Significances vs. Group 3: ^x $p < 0.05$; ^y $p < 0.02$; ^w $p < 0.01$; ^z $p < 0.001$. Significances vs. Group 2: ^a $p < 0.02$. SBP, systolic blood pressure; M, male; F, female.

Table 6. Bivariate Correlation Coefficients between Systolic or Diastolic Blood Pressure and Number of Weekly Servings of Some Food Groups

	Fish	Cheese	Salami	Cooked vegetables
SBP	-0.122 ^x	0.209 ^z	0.157 ^y	-0.162 ^w
DBP	-0.104 ^x	0.191 ^z	0.167 ^y	-0.103 ^x

Significances: ^x $p < 0.05$; ^y $p < 0.01$; ^w $p < 0.005$; ^z $p < 0.001$. SBP, systolic blood pressure; DBP, diastolic blood pressure.

a low-salt diet and 19% on a low-salt, low-energy diet) vs. 51% in the 2nd tertile (31% on a low-salt and 20% on a low-salt, low-energy diet) and only 33% in the 3rd tertile (19% on a low-salt and 14% on a low-salt, low-energy diet). This difference was statistically significant ($p < 0.01$). The mean energy intake in the three groups, calculated on the basis of the food record, and the percentage of calories from each source of macronutrients are indicated in Table 4. The same table also shows the calculated daily intake of sodium, potassium, calcium and magnesium. It is evident that the three groups did not differ significantly in regard to their total daily energy intake, but patients with better SBP control reported ingesting more calories from carbohydrates and less from saturated fats than the other groups, with a reduced intake of sodium chloride (3.3 ± 1 , 3.8 ± 2 , 4.1 ± 2 g daily, respectively) and an increased intake of potassium (3.5 ± 1 , 3.5 ± 1 , 3.1 ± 1 g daily, respectively). Accordingly, the daily intake of fiber was increased in the patients of the 1st tertile. The weekly numbers of main servings are shown in Table 5.

Finally, SBP and DBP were inversely correlated with weekly intake of fish and cooked vegetables and directly correlated with weekly intake of cheese and salami, as shown in Table 6.

Discussion

The regulation of BP levels depends on the interaction among different factors of both environmental and genetic origin (28). In observational studies a close relationship between BP values and BW has been shown; furthermore, intervention trials have demonstrated a significant reduction in BP levels in association with lifestyle and dietary changes (12, 29). According to the guidelines for the treatment of hypertension (11), all patients seen in our hypertension outpatient clinic discuss their dietary habits with dietitians and are informed about the necessary changes for optimizing their BP control. They are, therefore, instructed on how to reduce their salt intake and increase their potassium intake. Moreover, patients who need to reduce their BW are prescribed a severe hypocaloric diet (1,100 kcal) if their BMI is > 30 kg/m² or a moderate hypocaloric diet if their BMI is ≥ 26 kg/m² and < 30 kg/m². Patients with normal BW or mild overweight are suggested to follow a low-sodium diet without changes in the habitual caloric intake if it is within 2,200 kcal/day. Patients entered into the present study were able to reduce their BW during the period of intensive diet, but in the second phase we found in the vast majority of them a tendency to return to their habitual diet. Patients declared that they had quit their prescribed diet for at least 3 months, although, in many cases, they were still trying to reduce their total daily energy and salt intake and

change their food choices to healthier food groups (less saturated fats, and more legumes, vegetables and fish). At the time of the administration of the food intake questionnaire all patients had achieved a reduction in BW, which was of slightly lower degree in the group with the worst BP control.

Almost all patients were concomitantly on antihypertensive pills, and the compliance with the treatment was judged to be sufficiently accurate. The therapeutic goal of a BP <140/90 mmHg had been achieved in 2/3 of the patients, and that of optimal BP control had been achieved in about 1/3 of the patients.

The present data confirm that it is difficult to obtain good compliance with a diet over the long term, particularly when patients are no longer included in an intensive diet program of follow-up. On the other hand, a previous 3-year follow-up study showed that lifestyle modifications can be successfully implemented in the clinical setting (30). In the present study, patients with good and even those with optimal BP control remained overweight, and those with poor BP control were still obese. These unsatisfactory results were achieved despite the fact that the dieticians had reinforced the dietary message at each visit for 6 months and patients had been well informed that BW reduction is associated with the prevention of hypertension (31) and the reduction of antihypertensive drug dosage (32, 33). In this regard, the present study contributes the information that the beneficial effects of BW reduction might be blunted over time if patients discontinue their diet in terms of not only energy intake but also quality of food, even if they have not completely regained their previous BW.

This observation brings us to a second point of discussion: whether the effects on BP should be attributed to the change in BW or to the change in the nutritional intake. In the present study BW increased from the end of the initial care period to the time of the recruitment into the study in the same way in the three groups which, nevertheless, showed different BP levels. There is, obviously, no doubt that weight increase is associated with an increase in BP levels; the present study, however, found in addition that better BP control was also associated with the choice of food groups with less energy intake from saturated fats, compensated by a relative increase in calories from carbohydrates. The relationship between saturated fat intake and BP levels was previously reported in intervention trials but was not confirmed in a more recent study (34, 35). Regarding the influence on BP of monounsaturated olive oil, the main source of lipids in the diet of people living in the south of Italy, which previous investigations by another group and ourselves (18, 19) had found to be inversely associated with BP levels, the present investigation did not detect a difference in its consumption among the three BP tertile groups. However, it is interesting to note that, in keeping with the dietary habits in southern Italy, olive oil was found to be the main source of fat in all our patients, and its consumption did not antagonize the achievement of the therapeutic goal. On the other hand, increased intake of foods rich in saturated fats and salt, as cheese and salami are, was asso-

ciated with higher BP levels, while increased daily intake of legumes and vegetables, which are rich in indigestible fibers and potassium, and that of fish was associated with lower BP values. Regarding daily sodium intake, the three groups showed similar restriction even at the end of the follow-up period, despite their different levels of BP control: it is conceivable that the reduction in sodium intake may have contributed to the 18/8 mmHg reduction that was still observed at the end of the follow-up in the second group, as well as to the 3 mmHg reduction in DBP and the lack of increase in SBP in comparison to the baseline measurement in the third group. The reduction of salt intake was in agreement with a previous study in which a close control of dietary habits was found to strongly encourage salt restriction (36).

A third point to be discussed is the role of other noncaloric elements such as calcium and magnesium, which is still debated. In the present study we found that calcium intake was not associated with BP values, but magnesium intake was inversely associated with BP levels: patients with the worst BP control showed a 15% reduction of magnesium intake in comparison to patients in the first tertile.

A fourth point of discussion is related to the wine consumption, since moderate intake of wine has been suggested to lower BP. Unfortunately no conclusion may be drawn from the present study because the wine intake was very low and extremely similar among groups.

Finally, although the present study was performed in a population largely sedentary (almost 60% of the participants were sedentary), our results showed that patients with the best BP control were those who tried to perform at least some physical activity, even if only daily walking.

Limitations of the Study

The present trial design was chosen in order to work backwards from achieved pressure to see what, if any, parameters might have led to the differences observed, rather than attempt to look at the effect of diet on BP. This is, obviously, a less powerful tool than a randomized trial for determining cause and effect. A more powerful trial design would have been to randomize patients who had completed 6 months of an intensive diet either to stay on that diet or return to their usual diet and then see what happened to their BP. However, in this case, we would have had to discontinue, at least in some patients, an effective dietary treatment, which all recent guidelines indicate is essential in order to reduce the cardiovascular risk of these patients. Approval of such a trial would have been denied by the local ethics committee.

Conclusions

In conclusion, this study showed that an initial care program, including dietary treatment, was able to induce a significant reduction in BP and BW. However, along with the beneficial effects of a healthy diet on BP control, there are several diffi-

culties—in terms of total daily energy, salt intake and types of food consumed—that discourage the long-term compliance of hypertensive patients with a prescribed dietary regimen. This evidence strongly supports the notion that an integrated team of doctors, dieticians and psychologists should be placed in charge of the direction of the hypertension outpatient clinic in order to extend the initial care approach to hypertensive patients as long as possible. This program should associate to the drug treatment a continuous counseling of non-pharmacological measures, including nutritional habits and physical exercise, to reduce BP levels and prevent other metabolic abnormalities able to induce an enormous increase in the cardiovascular risk.

References

1. Stamler R, Stamler J, Riedlinger WF, Algera G, Roberts RH: Weight and blood pressure. Findings in hypertension screening of 1 million Americans. *JAMA* 1978; **240**: 1607–1610.
2. Kannel WB, Brand N, Skinner JJ Jr, Dawber TR, McNamara PM: The relation of adiposity to blood pressure and development of hypertension. The Framingham study. *Ann Intern Med* 1967; **67**: 48–59.
3. Reaven GM, Lithell H, Landsberg L: Hypertension and associated metabolic abnormalities—the role of insulin resistance and the sympathoadrenal system. *N Engl J Med* 1996; **334**: 374–381.
4. Simonson DC: Etiology and prevalence of hypertension in diabetic patients. *Diabetes Care* 1988; **11**: 821–827.
5. Asmar R, Vol S, Pannier B, Brisac AM, Tichet J, El Hasnaoui A: High blood pressure and associated cardiovascular risk factors in France. *J Hypertens* 2001; **19**: 1727–1732.
6. Assmann G, Schulte H: The Prospective Cardiovascular Munster Study: prevalence and prognostic significance of hyperlipidemia in men with systemic hypertension. *Am J Cardiol* 1987; **59**: 9G–17G.
7. Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults: Executive summary of the third report of the National Cholesterol Education Program (NCEP) Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III). *JAMA* 2001; **285**: 2486–2497.
8. Balkau B, Charles MA, Drivsholm T, et al, European Group for the Study of Insulin Resistance (EGIR): Frequency of the WHO metabolic syndrome in European cohorts, and an alternative definition of an insulin resistance syndrome. *Diabetes Metab* 2002; **28**: 364–376.
9. Sundström J, Risérus U, Byberg L, Zethelius B, Lithell H, Lind L: Clinical value of the metabolic syndrome for long term prediction of total and cardiovascular mortality: prospective, population based cohort study. *BMJ* 2006; **332**: 878–882.
10. Butler J, Rodondi N, Zhu Y, et al, Health ABC Study: Metabolic syndrome and the risk of cardiovascular disease in older adults. *J Am Coll Cardiol* 2006; **47**: 1595–1602.
11. Cifkova R, Erdine S, Fagard R, et al, ESH/ESC Hypertension Guidelines Committee: Practice guidelines for primary care physicians: 2003 ESH/ESC hypertension guidelines. *J Hypertens* 2003; **21**: 1779–1186.
12. Appel LJ, Brands MW, Daniels SR, Karanja N, Elmer PJ, Sacks FM, American Heart Association: Dietary approaches to prevent and treat hypertension: a scientific statement from the American Heart Association. *Hypertension* 2006; **47**: 296–308.
13. Neter JE, Stam BE, Kok FJ, Grobbee DE, Geleijnse JM: Influence of weight reduction on blood pressure: a meta-analysis of randomized controlled trials. *Hypertension* 2003; **42**: 878–884.
14. Sacks FM, Svetkey LP, Vollmer WM, et al, DASH-Sodium Collaborative Research Group: Effects on blood pressure of reduced dietary sodium and the Dietary Approaches to Stop Hypertension (DASH) diet. DASH-Sodium Collaborative Research Group. *N Engl J Med* 2001; **344**: 3–10.
15. Siani A, Strazzullo P, Giacco A, Pacioni D, Celentano E, Mancini M: Increasing the dietary potassium intake reduces the need for antihypertensive medication. *Ann Intern Med* 1991; **115**: 753–759.
16. Appel LJ, Moore TJ, Obarzanek E, et al: A clinical trial of the effects of dietary patterns on blood pressure. DASH Collaborative Research Group. *N Engl J Med* 1997; **336**: 1117–1124.
17. Xin X, He J, Frontini MG, Ogden LG, Motsamai OI, Whelton PK: Effects of alcohol reduction on blood pressure: a meta-analysis of randomized controlled trials. *Hypertension* 2001; **38**: 1112–1117.
18. Rasmussen OW, Thomsen C, Hansen KW, Vesterlund M, Winther E, Hermansen K: Effects on blood pressure, glucose, and lipid levels of a high-monounsaturated fat diet compared with a high-carbohydrate diet in NIDDM subjects. *Diabetes Care* 1993; **16**: 1565–1571.
19. Ferrara LA, Raimondi AS, D'Episcopo L, Guida L, Dello Russo A, Marotta T: Olive oil and reduced need for antihypertensive medications. *Arch Intern Med* 2000; **160**: 837–842.
20. Straznicki NE, Louis WJ, McGrade P, Howes LG: The effects of dietary lipid modification on blood pressure, cardiovascular reactivity and sympathetic activity in man. *J Hypertens* 1993; **11**: 427–437.
21. Morris MC, Sacks F, Rosner B: Does fish oil lower blood pressure? A meta-analysis of controlled trials. *Circulation* 1993; **88**: 523–533.
22. Whelton SP, Hyre AD, Pedersen B, Yi Y, Whelton PK, He J: Effect of dietary fiber intake on blood pressure: a meta-analysis of randomized, controlled clinical trials. *J Hypertens* 2005; **23**: 475–481.
23. Cappuccio FP, Elliott P, Allender PS, Pryer J, Follman DA, Cutler JA: Epidemiologic association between dietary calcium intake and blood pressure: a meta-analysis of published data. *Am J Epidemiol* 1995; **142**: 935–945.
24. Mizushima S, Cappuccio FP, Nichols R, Elliott P: Dietary magnesium intake and blood pressure: a qualitative overview of the observational studies. *J Hum Hypertens* 1998; **12**: 447–453.
25. Haslam DW, James WP: Obesity. *Lancet* 2005; **366**: 1197–1209.
26. Ciccarone E, Di Castelnuovo A, Salcuni M, et al, Gendiabe Investigators: A high-score Mediterranean dietary pattern is

- associated with a reduced risk of peripheral arterial disease in Italian patients with type 2 diabetes. *J Thromb Haemost* 2003; **1**: 1744–1752.
27. Friedewald WT, Lery RI, Fredrickson DS: Estimation of plasma low density lipoprotein cholesterol concentration without use of the preparative ultracentrifuge. *Clin Chem* 1972; **18**: 499–502.
28. Hubner N, Yagil C, Yagil Y: Novel integrative approaches to the identification of candidate genes in hypertension. *Hypertension* 2006; **47**: 1–5.
29. Ohta M, Nanri H, Matsushima Y, Sato Y, Ikeda M: Blood pressure-lowering effects of lifestyle modification: possible involvement of nitric oxide bioavailability. *Hypertens Res* 2005; **28**: 779–786.
30. Elmer PJ, Grimm R Jr, Laing B, *et al*: Lifestyle intervention: results of the Treatment of Mild Hypertension Study (TOMHS). *Prev Med* 1995; **24**: 378–388.
31. Effects of weight loss and sodium reduction intervention on blood pressure and hypertension incidence in overweight people with high-normal blood pressure. The Trials of Hypertension Prevention, phase II. The Trials of Hypertension Prevention Collaborative Research Group. *Arch Intern Med* 1997; **157**: 657–667.
32. Langford HG, Blaufox MD, Oberman A, *et al*: Dietary therapy slows the return of hypertension after stopping prolonged medication. *JAMA* 1985; **253**: 657–664.
33. Whelton PK, Appel LJ, Espeland MA, *et al*, TONE Collaborative Research Group: Sodium reduction and weight loss in the treatment of hypertension in older persons: a randomized controlled trial of nonpharmacologic interventions in the elderly (TONE). *JAMA* 1998; **279**: 839–846.
34. Puska P, Iacono JM, Nissinen A, *et al*: Controlled, randomised trial of the effect of dietary fat on blood pressure. *Lancet* 1983; **1**: 1–5.
35. Ascherio A, Hennekens C, Willett WC, *et al*: Prospective study of nutritional factors, blood pressure, and hypertension among US women. *Hypertension* 1996; **27**: 1065–1072.
36. Ohta Y, Tsuchihashi T, Onaka U, Eto K, Tominaga M, Ueno M: Long-term compliance with salt restriction in Japanese hypertensive patients. *Hypertens Res* 2005; **28**: 953–957.