Effect of a High-Carbohydrate Versus a High–cis-Monounsaturated Fat Diet on Blood Pressure in Patients With Type 2 Diabetes

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OBJECTIVE — To investigate whether blood pressure is different in type 2 diabetic patients on a diet rich in carbohydrates versus a diet rich in cis-monounsaturated fatty acids. Data on the dietary effects on these diets’ glucose and lipid metabolism have been previously published.

RESEARCH DESIGN AND METHODS — The study compared the effect of feeding 42 type 2 diabetic patients a carefully controlled isoenergetic high-carbohydrate (high-carb; 55% energy as carbohydrate, 30% as fat, and 10% as monounsaturated fat) and high–monounsaturated fat (high-mono; 45% energy as fat, 25% as monounsaturated fat, and 40% as carbohydrate) diet for 6 weeks each in a four-center, randomized, cross-over study on blood pressure. Twenty-one patients continued the diet they received during the second phase for an additional 8 weeks.

RESULTS — According to repeated-measures ANOVA, blood pressure during the last 3 days of each phase was similar after 6 weeks of the high-carb and high-mono diets (systolic blood pressure: 128 ± 16 vs. 127 ± 15 mmHg, P = 0.9; diastolic blood pressure: 75 ± 7 vs. 75 ± 8 mmHg, P = 0.7). However, after 14 weeks of the high-carb diet (n = 13), there was a significant increase in blood pressure compared with 6 weeks of the high-mono diet (systolic blood pressure: 132 ± 13 vs. 126 ± 11 mmHg, P = 0.04; diastolic blood pressure: 83 ± 6 vs. 76 ± 7 mmHg, P = 0.002). After 14 weeks of the high-mono diet (n = 8), the reduction in blood pressure was not significant compared with 6 weeks of the high-carb diet (systolic blood pressure: 118 ± 14 vs. 121 ± 16 mmHg, P = 0.4; diastolic blood pressure: 71 ± 8 vs. 75 ± 10 mmHg, P = 0.3).

CONCLUSION — Although the exchange of carbohydrates with monounsaturated fats may not affect blood pressure in the short term, long-term consumption of a high-carbohydrate diet may modestly raise blood pressure in type 2 diabetic patients.

Diabetes Care 28:2607–2612, 2005

It has been well established that replacing a high-carbohydrate diet with a diet rich in cis-monounsaturated fatty acids improves lipids and lipoproteins (1). Whether high–monounsaturated fat diets also improve blood pressure compared with high carbohydrate diets is controversial. Epidemiological studies show that cis-monounsaturated fat intake is higher in individuals with lower blood pressure (2,3).

The results of randomized intervention studies, which can determine cause and effect, in this area are conflicting. In a cross-over study in type 2 diabetic subjects, Rasmussen et al. (4) found that a high–monounsaturated fat diet lowered daytime ambulatory blood pressure but not auscultatory blood pressure compared with a high-carbohydrate diet. Lauszus et al. (5) reported a greater rise in 24-h ambulatory diastolic blood pressure with a high-carbohydrate diet than with a high–monounsaturated fat diet in women with gestational diabetes. However, Mensink et al. (6) found no difference in clinical blood pressure in normotensive subjects randomized to a high–monounsaturated fat or a high-carbohydrate diet. Three cross-over studies, two in type 2 diabetic subjects (7,8) and one in subjects with hyperlipidemia (9), also found no difference in 24-h ambulatory (7) or clinical (8,9) blood pressure on the two diets. These conflicting results could be due to a short study duration (21–36 days) in some studies (4,6,7,9); the small sample size of some cross-over (n = 10–15) (4,7) and parallel design (n = 27–47) (5,6) studies; the use of diets with large differences in saturated fat, fiber, or cholesterol content (4–6,8); or changes in patient body weight of >1 kg during the course of each diet (6). In addition, in one study, diets were only partially provided by the investigators (9).

Thus the purpose of the current investigation was to compare the long-term effects of carefully controlled isoenergetic high-carbohydrate and high–monounsaturated fat diets prepared in metabolic kitchens on blood pressure and heart rate in a four-center, randomized, cross-over trial in type 2 diabetic subjects. The effects of these diets on glucose and lipid metabolism, the main aim of the study, have been published previously (10).
RESEARCH DESIGN AND METHODS — We studied 42 patients (33 men and 9 women) with type 2 diabetes at the metabolic units of the Stanford University (Stanford, CA; n = 10), the University of Texas Southwestern Medical Center (Dallas, TX; n = 10), the University of Minnesota (Minneapolis, MN; n = 11), and the Veterans Affairs Medical Center (San Diego, CA; n = 11). The protocol for this study was approved by the institutional review boards of each university, and all patients gave informed written consent. Regarding ethnic background, 31 patients were white, 6 were African American, 4 were Hispanic, and 1 was Asian. Other subject characteristics (means ± SD) included age 58 ± 10 years (range 35–78), BMI 28.1 ± 2.9 kg/m² (range 23–33), systolic blood pressure 134 ± 18 mmHg (range 108–177), diastolic blood pressure 80 ± 9 mmHg (range 60–99), and heart rate 75 ± 8 bpm (range 60–100). Of the 11 subjects on blood pressure—lowering medication, 2 were on a diuretics, 5 were on a calcium channel blocker, 2 were on an ACE inhibitor, and 2 were on both an ACE inhibitor and a diuretic. The blood pressure medications of all these patients remained stable throughout the study.

A randomized, cross-over study was designed. The daily energy intake needed for weight maintenance was estimated by multiplying the calculated basal energy expenditure by an activity factor. All patients received each of the two isoenergetic study diets (a high-carbohydrate [high-carb] and a high—cis-monounsaturated fatty acid [high-mono] diet) for 6 weeks each during phases 1 and 2. There was a median interval of 7 days between the two diet periods.

To assess the longer-term effects of diets, all patients were invited to consume the second diet for an additional 8 weeks (phase 2 extension) without interruption; 21 patients chose to do so. Of these, 8 patients continued on the high-mono diet and 13 continued on the high-carb diet, for a total duration of 14 weeks on the diet.

All meals were prepared in the metabolic kitchens. The patients ate at least one meal per day at the metabolic units on weekdays; the remaining food was supplied in packages to be consumed at home. To monitor compliance, the patients were instructed to bring back any unconsumed food, were interviewed by dietitians, and were weighed during their visits.

Diets A set of four standard menus for each study diet was prepared for a 2,000-kcal intake. For a different energy level, all food items were adjusted accordingly. The high-carb diet provided 55% of total energy as carbohydrate and 30% as fat. The high-mono diet provided 45% of total energy as fat and 40% as carbohydrate. The saturated and polyunsaturated fats (10% of the total energy intake each), protein (15% of total energy), cholesterol (120 mg per 1,000 kcal), and sucrose (10% of the total energy) contents of the study diet were matched. The content of dietary fiber was kept proportional to the carbohydrate content (high-mono: 11 g/1,000 kcal; high-carb: 15 g/1,000 kcal). The patients were instructed to maintain their usual level of physical activity and salt intake. The energy intake was adjusted if needed to maintain constant body weight during the study.

Blood pressure and heart rate measurements During the last 3 days of each phase, the patients were admitted to the inpatient metabolic unit of each center, where blood pressure and heart rate were measured daily using a mercury sphygmomanometer and palpation, respectively. The subjects did not engage in any physical activity or smoke. The blood pressure measurements were made on the left arm with the subjects sitting in a quiet room and were taken by the same staff. Systolic blood pressure was recorded in phase 1.

Figure 1 — Weekly mean (± SE) systolic (A) and diastolic (B) blood pressure in 41 patients on the high-carb (○, ●) and high-mono (△, ▲) diets during phases 1 and 2. ○, △, outpatient values; ●, ▲, inpatient values.
and diastolic blood pressure in phase V Korotkoff (12). The mean of the measures taken during the last 3 days of each phase were used to compare differences among the different phases; three values were recorded in >75% of the times. Blood pressure and heart rate were also measured weekly during all the remaining weeks on an outpatient basis after a 5-min rest.

**Statistical analyses**

Repeated-measures ANOVA (performed using SAS Version 9.1) was used to assess the impact of the study diets, the order in which patients received the diets, and the site of study participation on blood pressure and heart rate for 6 weeks (phases 1 and 2) in 41 patients and for 14 weeks (phases 1, 2, and 2 extension) in 21 patients. Only 1 patient was dropped from the 6 weeks’ analysis for lack of blood pressure data. Least-square means contrasts were used to analyze the differences among the three phases (phases 1, 2, and 2 extension) when ANOVA revealed significant diet effects. The effects of possible confounding factors such as age, sex, and weight were also evaluated using repeated-measures ANOVA and covariance models; these covariates did not affect the blood pressure and heart rate response to the diets.

**RESULTS** — The compliance to both the study diets was excellent. The sites at which the patients were studied did not significantly affect the results, so combined results from all four centers are presented. Excluding the subjects who were on blood pressure—lowering medication did not affect the responses, so data on all the subjects are presented below.

**Phases 1 and 2 (41 patients)**

During the last 3 days of phases 1 and 2, energy intake (high-mono: 2,533 ± 366 kcal; high-carb: 2,528 ± 375 kcal; \( P = 0.8 \)) and body weight (high-mono: 82.2 ± 11.8 kg; high-carb: 82.3 ± 12.2 kg; \( P = 0.8 \)) were similar on the two diets.

The order in which the patients received the diets did not affect the results. After 6 weeks of the high-carb or high-mono diet, no difference was observed in systolic (128 ± 16 vs. 127 ± 15 mmHg; \( P = 0.9 \)) or diastolic (75 ± 7 vs. 75 ± 8 mmHg, respectively; \( P = 0.7 \)) blood pressure. Heart rate was slightly higher on the high-carb than on the high-mono diet (73 ± 8 vs. 71 ± 8 bpm; \( P = 0.06 \)). Analysis of the weekly blood pressure collected during the outpatient follow-up (Fig. 1A and B) found no difference on the two diets (systolic blood pressure: \( P = 0.21 \); diastolic blood pressure: \( P = 0.12 \)).

**Phases 1, 2, and 2 extension (21 patients)**

There were no differences in energy intake or body weight during the last 3 days of phases 1, 2, and 2 extension in the 13 patients who received the high-carb diet for 14 weeks (energy intake: 2,587 ± 363, 2,601 ± 374, and 2,601 ± 374 kcal, respectively, \( P = 0.38 \); body weight: 83.1 ± 11.6, 83.3 ± 11.9, and 83.8 ± 12.4 kg, respectively, \( P = 0.16 \)) or in the 8 patients who received the high-mono diet for 14 weeks (energy intake: 2,550 ± 417, 2,550 ± 417, and 2,550 ± 417 kcal, respectively, \( P = 1.0 \); body weight: 81.3 ± 8.3, 80.7 ± 8.3, and 80.9 ± 8.9, respectively, \( P = 0.57 \)).

The longer-term analysis of the effects of the study diets on systolic and diastolic blood pressure and heart rate during the last 3 days of phases 1, 2, and 2 extension in the subgroup of 21 patients showed a significant order-by-diet interaction (\( P = 0.007, 0.002, \) and 0.02, respectively), so the results are presented in the order in which the patients received the diets. Table 1 shows the results in 13 patients who received the high-mono diet for 6 weeks during phase 1 and the high-carb diet for 14 weeks during phases 2 and 2 extension. There was a significant diet effect for diastolic blood pressure (\( P = 0.003 \)) and heart rate (\( P = 0.03 \)). Diastolic blood pressure and heart rate were significantly higher (7 mmHg; \( P = 0.002–0.004 \); 7–8 bpm, \( P = 0.01–0.04 \)) on the high-carb diet at 14 weeks than on the high-mono or the high-carb diet at 6 weeks. For both diastolic blood pressure and heart rate, there was no difference between the high-carb and high-mono diets at 6 weeks. There was no significant diet effect for systolic blood pressure; however, it was higher (6 mmHg; \( P = 0.04 \)) on the high-carb diet at 14 weeks than on the high-mono diet at 6 weeks, and the difference was reflected in the confidence intervals of 0.4–10.5 mmHg.

Table 1 shows the results during the last 3 days of each phase in eight patients who received the high-carb diet for 6 weeks during phase 1 and the high-mono diet for 14 weeks during phases 2 and 2 extension. The diet effect was significant for heart rate (\( P = 0.05 \)), which was lower on the high-mono diet at 14 weeks (7 bpm; \( P = 0.02 \)) and 6 weeks (6 bpm; \( P = 0.05 \)) than on the high-carb diet at 6 weeks. There was no significant diet effect for systolic or diastolic blood pressure, although they were lower (3–4 mmHg) on the high-mono diet at 14 weeks than on the high-carb diet at 6 weeks.

Analysis of the weekly blood pressure collected during outpatient follow-up in phases 1, 2, and 2 extension showed a significant order by diet interaction for systolic (\( P = 0.03 \)) and diastolic (\( P = 0.04 \)) blood pressure. Figure 2A shows the weekly mean systolic and diastolic

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**Table 1—Systolic and diastolic blood pressure and heart rate on the two diets in patients who participated in the phase 2 extension**

<table>
<thead>
<tr>
<th></th>
<th>High-mono diet</th>
<th>High-carb diet</th>
<th>Week 6</th>
<th>Week 14</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>126 ± 11*</td>
<td>129 ± 15</td>
<td>132 ± 13</td>
<td>0.11</td>
<td></td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>76 ± 7*</td>
<td>76 ± 5*</td>
<td>83 ± 6</td>
<td>0.003</td>
<td></td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
<td>70 ± 7*</td>
<td>71 ± 4*</td>
<td>78 ± 12</td>
<td>0.03</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>High-carb diet</th>
<th>High-mono diet</th>
<th>Week 6</th>
<th>Week 14</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic blood pressure (mmHg)</td>
<td>121 ± 16</td>
<td>125 ± 13§</td>
<td>118 ± 14</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>Diastolic blood pressure (mmHg)</td>
<td>75 ± 10</td>
<td>76 ± 11</td>
<td>71 ± 8</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>Heart rate (bpm)</td>
<td>73 ± 11¶</td>
<td>67 ± 10</td>
<td>66 ± 10</td>
<td>0.05</td>
<td></td>
</tr>
</tbody>
</table>

Data are means ± SD. A total of 21 patients participated in the phase 2 extension. Data on blood pressure and heart rate are missing in one subject for the 14-week high-carb diet. \( P \) values were determined from repeated-measures ANOVA and indicate the differences among the three periods within each sequence (A or B). Study sequence A: \( *P < 0.05, †P < 0.005, ‡P = 0.01 \) vs. 14-week high-carb diet value; study sequence B: \( \S P < 0.05 \) vs. 14-week high-mono value, \( \| P < 0.05 \) vs. 6-week high-mono diet value.
blood pressure in 13 patients who received the high-mono diet for 6 weeks during phase 1 and the high-carb diet for 14 weeks during phases 2 and 2 extension. There was no significant diet effect \( (P = 0.8) \) for either systolic or diastolic blood pressure, although they tended to be higher during the high-carb phase than at the end of the high-mono phase. Figure 2B shows the weekly mean systolic and diastolic blood pressure in the eight patients who received the high-carb diet for 6 weeks during phase 1 and the high-mono diet for 14 weeks during phases 2 and 2 extension. There was a significant diet effect for both systolic \( (P = 0.03) \) and diastolic \( (P = 0.03) \) blood pressure. Systolic and diastolic blood pressure were significantly lower on the high-mono diet during the phase 2 extension than on the high-carb diet during phase 1 \( (P = 0.009 \) and \( P = 0.01 \), respectively). The results were similar even when the inpatient data were excluded from the analysis.

CONCLUSIONS—We compared the effects of isoenergetic high-carb and high-mono diets in a four-center, randomized, cross-over trial on blood pressure in type 2 diabetic subjects while holding body weight and intake of saturated fat, polyunsaturated fat, and cholesterol constant across diets. Based on the data collected in the inpatient metabolic units, the exchange of carbohydrates with monounsaturated fats did not affect blood pressure at 6 weeks but did have a modest impact on this measure in the longer term. In subjects who received the high-mono diet for 6 weeks and the high-carb diet for 14 weeks, blood pressure was significantly higher on the latter diet. In subjects who received the high-carb diet for 6 weeks and the high-mono diet for 14 weeks, blood pressure was higher on the former diet, but the difference did not reach statistical significance, possibly because of the smaller sample size.

The 6-week results from our study were not corroborated by the results from the 3-week cross-over study in type 2 diabetic subjects conducted by Rasmussen et al. (4) in which daytime ambulatory blood pressure was higher on a high-carbohydrate diet than on a high-monounsaturated fat diet. A possible reason why that study found a blood pressure response to the diets at 3 weeks compared with our study, in which a small difference was seen only with longer-term consumption of the diets, could be partly due to the fact that their study had a higher difference in the percentage of energy from monounsaturated fat between the two diets (high-monounsaturated fat diet: 30%; high-carbohydrate diet: 10%) than that in the present study (high-mono diet: 25%; high-carb diet: 10%). The smaller difference in monounsaturated fat content in our study may have led to a delayed blood pressure response, suggesting that long-term studies may be necessary to evaluate the blood pressure response to high-carbohydrate and high-monounsaturated fat diets, especially when the difference in monounsaturated fat content of the two diets is at the level shown in our study. It is not clear why Rasmussen et al. (4) did not find a difference in nighttime blood pressure and clinic blood pressure on the two diets.

A number of other studies that also compared high-carbohydrate and high-monounsaturated fat diets, however, did not find a difference in the blood pressure response (6–9). The results from these studies are difficult to compare with the results from our study, however, as most of the studies (6,7,9) were only 21–36 days in duration, whereas for some patients in our study, phases 2 and 2 extension were implemented for a total of 14 weeks. The short duration of the former studies may have been a limiting factor leading to a possible delayed response. Also, in two of the four studies (6,8), the percentage of energy from saturated fat was higher (2–3.2%) and the dietary fiber content was lower (9–18 g) on the high-monounsaturated fat diet compared with the high-carbohydrate diet. These differences could have mitigated any possible
blood pressure — lowering effect of mono-
unsaturated fat as diets high in saturated
fat or low in fiber have been reported to
raise blood pressure (13,14). In our
study, the percentage of energy intake
from saturated fat was held constant
across the two diets (10% of total energy),
and dietary fiber intake was kept propor-
tional to the carbohydrate content; thus, a
patient on a 2,000-kcal diet would have
received 22 g of dietary fiber on the high-
mono diet and 30 g on the high-carb diet.
Based on a meta-analysis by Streppel et al.
(14) in which an average fiber supple-
mentation of 11.5 g/day reduced systolic blood
pressure by 1.13 mmHg, the differences in blood pressure between the
two diets in the present study might have
been slightly higher had the fiber content
of the high-mono diet been as high as the
fiber content of the high-carb diet.

The most plausible mechanism for an
increase in blood pressure and heart rate
on a high-carbohydrate diet compared with
a high–monounsaturated fat diet might be the accentuation of hyperinsu-
linemia. Data on insulin concentration in
the present study that were previously re-
ported (10) showed that compared with the
high-mono diet, the high-carb diet in-
creased daylong plasma insulin values by
10% and that the effects persisted for 14
weeks. It has been postulated that hyper-
insulinemia enhances sympathetic ner-
vous system activity, which increases
heart rate, cardiac output, vascular resis-
tance, and Na+ retention and thus blood
pressure (15,16).

A possible limitation of the present
study is the fact that we did not record
24-h ambulatory blood pressure. Accord-
ing to one study (17), the variability in
blood pressure measurements is twice as
large for clinic measurements as for am-
bulatory measurements, although the dif-
ference between clinic and average
daytime ambulatory blood pressure in
this study was not significant. Our vari-
ability was probably minimized, how-
ever, because the measurements were
made under controlled inpatient condi-
tions and because the sample size in our
cross-sectional study was large. Neverthe-
less, future studies need to investigate the
long-term effects of these diets using the
24-h ambulatory blood pressure method
because of the variability in blood pressure
during the day and night and the ability of
the method to observe blood pressure be-
havior during normal daily activities.

It has been suggested that decreases
in blood pressure in a trial may be due to
a habituation effect (18). Blood pressure
decreased slightly on the high-mono ex-
tension phase in our study. However, we
do not believe this change was due to a
habituation effect, given the fact that a sig-
nificant rise in blood pressure was ob-
served during the high-carb extension
phase. Also, the lowering of blood pres-
sure due to habituation reaches a plateau
after 1 week (18).

Another possible limitation of this
study was that we did not specifically con-
трол the intake of minerals linked to blood
pressure. According to meta-analyses, pot-
sassium supplementation leads to a signif-
icant reduction in blood pressure (19); 
magnesium supplementation leads to a
small, nonsignificant decrease in blood
pressure (20); and calcium supplementa-
tion is inconsistently linked to blood pres-
sure (21). Also, decreasing sodium intake
may lead to lower blood pressure (22). Based
on the menus for the 2,000-kcal
diets in our study, the intake of sodium,
potassium, magnesium, and calcium was
345, 574, 90, and 79 mg higher, respec-
tively, on the high-carb diet than on
the high-mono diet. The higher sodium con-
tent of the high-carb menus is unlikely to
have contributed to a higher blood pres-
sure as the total sodium content of the
high-carb menus was only 1,546 mg/day;
in addition, the menus had a higher po-
tassium content to balance out any possi-
ble effect of sodium on blood pressure.
The difference in magnesium and calcium
content between the two diets is too small
to result in any clinically relevant differ-
ence in blood pressure (20,21).

In conclusion, over a short period,
high-carbohydrate and high–monounsat-
urated fatty acid diets are not related to
blood pressure, but over a longer period
(e.g., here 14 weeks), a high-carbohy-
drate diet may modestly increase blood
pressure compared with a high–
monounsaturated fat diet.

Acknowledgments — This study was sup-
ported in part by a grant from Pfizer (New
York, NY); National Institutes of Health
Grants M01-RR00633, M01-RR-00400,
M01-RR-00827, M01-RR0070, HL-29252,
HL-08506, and DK-38949; and the Medical
Research Service of the San Diego (CA) Veter-
ans Affairs Medical Center.

References
1. Garg A: High-mono-unsaturated-fat diets
for patients with diabetes mellitus: a
meta-analysis. Am J Clin Nutr 67 (Suppl.):
577S–582S, 1998
2. Keys A: Coronary heart disease in seven
countries. Circulation 41 (Suppl. 1):1–
211, 1970
3. Williams P, Fortmann SP, Terry RB, Ga-
ray SC, Vranizan KM, Ellsworth N, Wood
PD: Associations of dietary fat, regional
adiposity, and blood pressure in men.
JAMA 257:3251–3256, 1987
4. Rasmussen OW, Thomsen C, Hansen
KW, Vestelund M, Winther E, Her-
mansen K: Effects of blood pressure,
glucose, and lipid levels of a high–mo-
ounsaturated fat diet compared with a
high-carbohydrate diet in NIDDM sub-
jects. Diabetes Care 16:1565–1571, 1993
5. Lauszus FF, Rasmussen OW, Henriksen
JE, Klebe JG, Jensen L, Lauszus KS, Her-
mansen K: Effect of a high–mono-unsat-
urated fat diet on blood pressure and
glucose metabolism in women with gesta-
tional diabetes mellitus. Eur J Clin Nutr
6. Mensink RP, Janssen MC, Katan MB. Ef-
fect on blood pressure of two diets differ-
in in total fat but not in saturated fat and
polyunsaturated fatty acids in healthy vol-
7. Nielsen S, Hermansen R, Rasmussen OW,
Thomsen C, Mogensen CE: Urinary albu-
min excretion rate and 24-h ambulatory
blood pressure in NIDDM with mi-
croalbuminuria: effects of a mono-unsat-
urated-enriched diet. Diabetologia 38:
1069–1075, 1995
8. Walker KZ, O’Dea K, Nicholson GC, Muir
JG: Dietary composition, body weight,
and NIDDM. Diabetes Care 18:401–403,
1995
9. Jenkins DJA, Kendall CWC, Marchie A,
Parker TL, Connelly PW, Qian W, Haight
JS, Faulkner D, Viggen E, Lapsley KG,
Spiller GA: Dose response of almonds on
coronary heart disease risk factors: blood
lipids, oxidized low-density lipoproteins,
lipoprotein(a), homocysteine, and pul-
monary nitric oxide: a randomized, con-
trolled, cross-over trial. Circulation 106:
1327–1332, 2002
AM, Griver KA, Raatz SK, Brinkley L,
Chen L, Grundy SM, Huet BA, Reaven
GM: Effects of varying carbohydrate con-
tent of diet in patients with non-insulin
dependent diabetes mellitus. JAMA 271:
1421–1428, 1994
11. Harris JA, Benedict GG: A Biometric
Study of Basal Metabolism in Man. Wash-
ington, DC, Carnegie Institutes of Washing-
ton, 1919 (publ. no. 279)
Committee on Detection, Evaluation, and
Treatment of Blood High Blood Pressure.
Arch Intern Med 148:1023–1038, 1988
13. Strazzullo P, Ferro-Luzzi A, Siani A, Scac-
cini C, Sette S, Catasta G, Mancini M:
Diet and blood pressure in type 2 diabetes


