Boiled Coffee and Blood Pressure

A 14-Week Controlled Trial

Marijke van Dusseldorp, Paul Smits, Jacques W.M. Lenders,
Theo Thien, and Martijn B. Katan

The question of whether long-term elimination of coffee from the diet lowers blood pressure has not been settled. Consumption of Scandinavian-style "boiled coffee" is associated with coronary heart disease. However, little is known about the effect of brewing method on the blood pressure–raising potential of coffee. We have studied the effects on blood pressure and heart rate of total elimination of coffee and tea in comparison with drinking boiled coffee consumed as such, or boiled coffee consumed after filtration through paper filter. Thirty-one women and 33 men first consumed 6 cups/day of boiled and filtered coffee for 17 days. Then they were randomly divided into three groups, which for the next 79 days received either unfiltered boiled coffee (caffeine content 860 mg/l), boiled-and-filtered coffee (887 mg caffeine/l), or no coffee, the latter being replaced by fruit juice and mineral water. Total elimination of coffee did not significantly affect blood pressure or heart rate relative to boiled-and-filtered coffee. In subjects who drank boiled coffee, mean ambulant systolic blood pressure rose significantly relative to those who consumed boiled-and-filtered coffee (mean difference±SEM, 3.1±1.1 mm Hg, $p=0.006$). This response showed a tendency to be stronger for women (4.5±1.8 mm Hg) than for men (1.7±1.2 mm Hg). We conclude that elimination of filtered coffee has no substantial long-term effect on blood pressure, but consumption of unfiltered boiled coffee may cause a slight but significant rise in systolic blood pressure. (*Hypertension* 1991;18:607–613)

Whether long-term elimination of caffeine-containing coffee from the diet will lower blood pressure is a question that has not been settled. Epidemiological studies comparing coffee users and abstainers have yielded contradictory findings.[1–6] Results of recent trials have suggested that abstinence from drip-filtered[7] or instant[8] coffee for a period of 4–9 weeks may slightly reduce blood pressure. However, these results are difficult to interpret because there were differences among treatment groups in blood pressure levels at baseline and in body weight changes during treatment[7] or because outcomes varied depending on the posture of subjects during the measurements.[8] Dietary control was also lacking in both trials.

The effects of different coffee brewing methods on blood pressure and heart rate are also largely unknown. In the aforementioned study of Bak and Grobbee,[7] drip-filtered coffee was also compared with Scandinavian-style "boiled" coffee, but no differences in effects on blood pressure or heart rate were found. Several studies have reported on the hypercholesterolemic effect of boiled coffee[9–11]; this effect is eliminated by filtration of the coffee through a paper filter.[12] Observations on Norwegian men and women, most of whom consumed boiled coffee, suggested that coffee may affect mortality from coronary heart disease over and above its effect in raising cholesterol concentration.[13] High blood pressure could form a link between boiled coffee consumption and coronary heart disease, but information on the effects of boiled coffee on blood pressure and heart rate is scarce.

We studied the effects on blood pressure and heart rate of total elimination of coffee and tea in comparison with boiled coffee consumed as such, and with boiled coffee consumed after filtration through commercial paper coffee filters. The effect of these treatments on serum lipoproteins are described elsewhere.[12]

Methods

Subjects

The subjects were volunteers from the general population living in or near Nijmegen, a mixed

From the Department of Medicine, Human Nutrition Section (M. van D., M.B.K.), and the Division of General Internal Medicine (P.S., J.W.M.L., Th.T.), University of Nijmegen, Nijmegen, The Netherlands.

Supported by grant 88.060 from the Netherlands Heart Foundation.

Address for reprints: Dr. M. van Dusseldorp, University of Nijmegen, Department of Medicine, Human Nutrition Section, P.O. Box 9101, 6500 HB Nijmegen, The Netherlands.

Submitted January 24, 1991; accepted in revised form July 16, 1991.

TABLE 1. Baseline Characteristics of the Three Study Groups

Characteristic	Boiled coffee (n=22)	Boiled-and-filtered coffee (n=21)	No coffee (n=21)
Sex (M/F)	11/11	11/10	11/10
Age (yr)	39±6	39±9	39±8
Body mass index (kg/m^2)	23±2	24±3	22±2
Blood pressure (mm Hg)			
Systolic	121±16	121±15	123±14
Diastolic	77±10	78±7	80±9
Heart rate (beats/min)	67±10	75±12	73±12

Values are mean±SD. Baseline blood pressures were measured with a regular sphygmomanometer.

industrial/college town of 150,000 inhabitants in the eastern Netherlands. They were recruited via stories in local newspapers and posters in university buildings. After they had been thoroughly informed about the purpose and protocol of the study, 167 subjects declared themselves eager to participate and filled out a questionnaire. One hundred subjects met our criteria for initial eligibility, which were: age 17–57 years, apparently healthy, abstinence from smoking for at least 1 year, not on medication, not on a prescribed diet, not using oral contraceptives, not pregnant, not working night shifts. The participants were further selected on a habitual consumption of 4–7 cups of regular drip-filtered coffee per day, a daily intake that is representative for the coffee users among the Dutch population.[14] The 100 eligible subjects subsequently participated in a physical and laboratory examination and recorded their fluid intake for 5 consecutive days. Thirty-four subjects proved ineligible because of high blood pressures (n=6) or high body mass index (n=3), because of various medical (n=8) or nonmedical (n=2) reasons, or because they drank less than 3 or more than 7 cups of coffee or more than 5 alcoholic consumptions per day (n=15). The remaining 33 women and 33 men were admitted to the study. All had completed secondary school, and 52% had completed college. Two women withdrew from the study during the run-in period, one for medical and one for personal reasons. Thus, data from 64 subjects were analyzed. Table 1 provides their baseline characteristics. The means and the standard deviations of these characteristics were quite similar for the three groups, showing that randomization had been successful.

The protocol for the study, which had been approved by the ethical committee of the University, was explained to the volunteers, and all subjects gave their written informed consent. The subjects were asked to maintain their usual pattern of activity and to maintain a stable body weight.

Coffee Preparation

The subjects were instructed to prepare and drink 0.9 l coffee brew/day, except for subjects in the no-coffee group during the test period (see "Design"). Boiled coffee was prepared by pouring 0.5 l boiling water onto 25 g coarsely ground caffeinated coffee (Roodmerk, Douwe Egberts, Utrecht, The Netherlands) in a 0.5 l Thermos flask. Ten minutes later the liquid was decanted into a second Thermos flask, from which the coffee beverage was poured out into a cup just before consumption. One batch provided 3 0.15-l cups of coffee (5 fl. oz.; 8 g of ground coffee/cup), which were usually consumed within half a day; then the bottles were cleaned out, and another 0.45-l batch was prepared for the second half of the day. Most of the coffee grounds stayed behind in the first or second Thermos bottle. Those grounds that made their way into the cup were discarded by subjects. Boiled and filtered coffee was prepared like the boiled coffee, but the liquid was poured into the second Thermos flask through a white Melitta paper filter (Melitta Nederland, Veenendaal, The Netherlands, 1×4, no. 4006508 200016) in a conical plastic filter holder. Subjects in both groups were allowed to dilute the brew in the second Thermos bottle with hot water if they found it too strong for their liking.

The mean±SD caffeine content was 860±13 mg/l for the boiled and 887±6 mg/l for the boiled and filtered coffee.

Design

The study lasted 14 weeks, from September 11 until December 15, 1989. Before randomization, subjects were grouped according to sex and to blood pressure level (above/below median). This yielded four subgroups: women-high, women-low, men-high, and men-low. Within each subgroup, subjects were grouped into triplets of similar age, and each member of a triplet was randomly allocated to one of the three treatments. During a run-in period of 17 days, all subjects consumed 6 cups boiled and filtered coffee/day. The run-in period was followed by a test period of 79 days, during which one third of the subjects consumed 6 cups boiled coffee/day, one third consumed 6 cups boiled and filtered coffee, and one third consumed no coffee at all.

In addition, all subjects received 2 cups herbal tea (Kneipp, Würzburg, FRG, and Salus Haus, Bruckmühl, FRG) during the run-in period as a source of fluid free from caffeine and other methylxanthines. All subjects continued to take these 2 cups of herbal tea during the entire study period. Subjects in the no-coffee group discontinued all caffeine-containing beverages after completion of the run-in period; during the test period they received instead 1 glass of orange or apple juice, 1 glass of mineral water, and 2 extra cups of herbal tea per day. Only nonmedicinal herbal teas that complied with the strict food safety regulations of the Federal Republic of Germany were used. The teas mainly consisted of mint, rosehips, chamomile, apple, blackberry, and hibiscus. The coffee, paper filters, coffee milk, herbal tea, juices, and mineral water were provided by us. For all

subjects, consumption of regular tea and other caffeine-containing products and preparations was prohibited, with the exception of chocolate, which was allowed in amounts of up to 15 g/day, providing up to 15 mg caffeine. Throughout the trial subjects met once per week with a dietitian who checked food intake by a 24-hour dietary recall, weighed the subject, gave out his or her packages for the next week, and collected the empty packages from the previous week. Subjects recorded in diaries any signs of illness, medications used, amounts of chocolate eaten, and any further deviation from the protocol. Frequent contacts with the investigators and a weekly newsletter helped to keep up the subjects' morale.

Blood Pressure and Heart Rate Measurements

Subjects measured their ambulant blood pressure and heart rate at 7:30 and 10:00 AM and at 1:00, 5:30, and 10:30 PM one day per week during each of the 14 weeks of the trial. In addition, blood pressure was measured on the first day of the test period. After a 5-minute rest in a sitting position, four measurements were recorded per session. Subjects used portable automatic blood pressure devices with the oscillometric method; 15 Takeda Medical UA-751 devices were obtained from Adquipment Medical BV, Rotterdam, The Netherlands, and 49 highly similar machines carrying the "Boso Oscillomat" logo were obtained from Bosch & Sohn GmbH u. Co., Jungingen, FRG. We have previously validated this type of device against a standard sphygmomanometer.[15] Each subject had his own blood pressure device that he used at all times. Blood pressure, heart rate, date, and time were printed automatically, and the printed output was collected and checked by the dietitian at each weekly visit. We discarded the first measurement of each session and averaged the other three. The average ambulant blood pressure was calculated for each measurement day as the average of the five session means. The measurement days were randomly divided over the different days of the week. Measurements on days 7, 12, and 17 (run-in period) were taken on the same days of the week as those on days 77, 84, and 89.

On days 14 and 75, blood pressure was also measured at our out-patient hypertension clinic with a noninvasive automatic device, the Arteriosonde 1225 (Roche, Medical Electronic Division, Orangeburg, N.J.). The recordings took place in the afternoon at a time when subjects in the coffee groups had consumed 3 cups of coffee before noon and none thereafter. After subjects had rested supine for 16 minutes, we took three supine blood pressure readings at 2-minute intervals, and after another 16 minutes of supine rest, we took another three readings. The six readings were averaged to give the hospital blood pressure.

Blood Sampling and Analysis

Nonfasting blood samples were collected on days 32, 58, and 82 in the afternoon to check caffeine levels. Serum was obtained by low-speed centrifugation within 1.5 hour and stored at −80°C. Serum caffeine was measured by reversed-phase, high-performance liquid chromatography.[16]

Statistical Analysis

The response of blood pressure and heart rate to the various treatments was calculated for each subject as the change from the run-in period (ambulant recordings: mean of days 7, 12, and 17; hospital recordings: day 14) to the end of the test period (ambulant recordings: mean of days 77, 84, 89, and 94; hospital recordings: day 75). Responses of systolic and diastolic blood pressure and heart rate were normally distributed. Effects of drinking coffee versus no coffee were examined by t test. Differences in response among the three groups were examined by analysis of variance using the General Linear Model procedure of the Statistical Analysis System[17] with group, gender, and group × gender interaction as independent variables. When this indicated a significant treatment effect ($p<0.05$), the responses to boiled coffee or no coffee were compared with the response of the group drinking boiled and filtered coffee. Since this involved two simultaneous comparisons, probability was set at 0.025 instead of 0.05. Treatment effects were adjusted for changes in body weight during the test period using multiple regression.[17] Probability values are two-tailed.

Compliance

Ninety-eight percent of all 20,866 packages of coffee, tea, paper filters, fruit juice, and mineral water were returned empty by the subjects. During the test period the mean±SD serum caffeine level was 4.9±2.2 mg/l (range, 2.2–11.1) in the boiled-coffee group, 4.7±2.4 mg/l (range, 1.2–9.4) in the boiled-and-filtered-coffee group, and 0.4±1.1 mg/l (range, 0.1–5.2) in the group that drank no coffee. One woman in this group had high serum caffeine levels at all occasions (5.0, 6.2, 4.4; mean 5.2 mg/l). If her data were eliminated, the mean±SD serum caffeine level in the no-coffee group became 0.1±0.1 mg/l (range, 0.1–0.3). In the boiled-and-filtered-coffee group, one man had used a faulty method to prepare the coffee and one woman was admitted to a hospital directly after the trial had ended because of a poor physical and mental condition. All analyses were performed both with and without the data of these three subjects.

Analysis of the diaries revealed no changes in physical activity throughout the study period. Evaluation of all weekly dietary recalls showed no significant changes in the intake of sodium or calcium throughout the study. However, from the run-in to the end of the test period the change in the intake of potassium differed significantly among groups (+370 mg/day for the boiled-coffee group, −304 mg/day for the boiled-and-filtered-coffee group, −35 mg/day for the no-coffee group, analysis of variance: $p=0.03$). Despite an increase in the energy intake in the boiled-coffee group when compared with both other

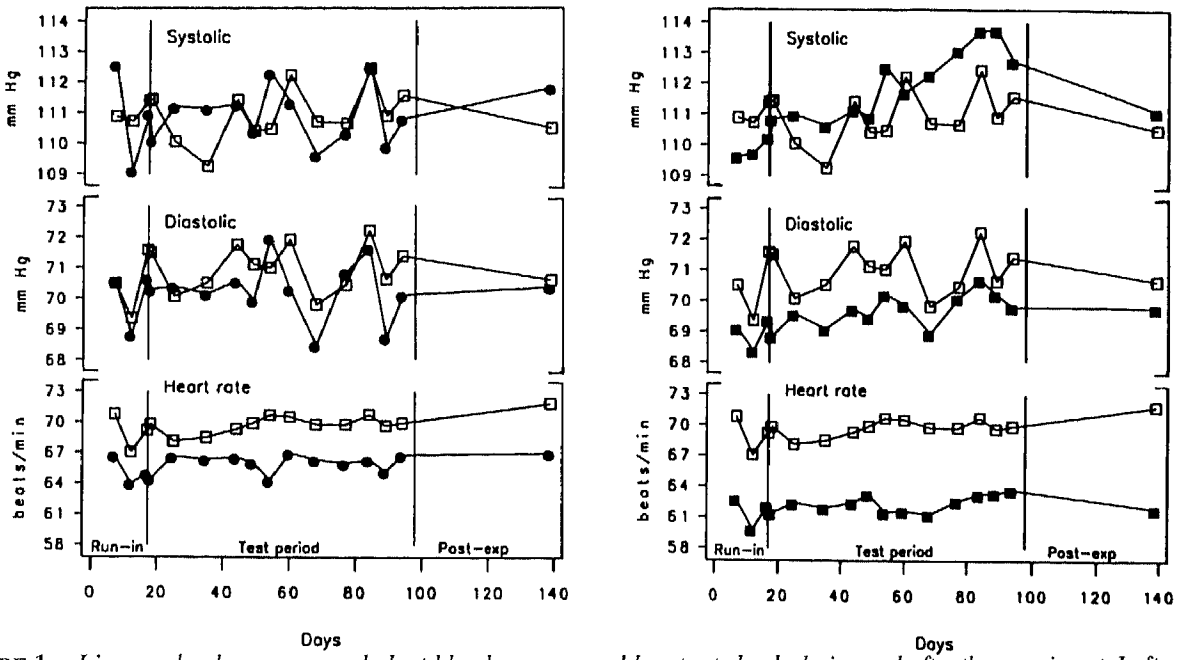

FIGURE 1. *Line graphs show mean ambulant blood pressure and heart rate levels during and after the experiment.* Left panel, *data for the no-coffee* (●) *group.* Right panel, *data for the boiled-coffee* (■) *group. Data for the boiled-and-filtered-coffee* (□) *group are presented in both panels. All 64 subjects drank 6 cups of boiled-and-filtered coffee during the run-in period. For the next 79 days, 21 subjects continued the consumption of boiled-and-filtered coffee (reference group for both panels), 21 subjects abstained from coffee (left panel), and 22 subjects drank 6 cups boiled coffee/day (right panel).*

groups, the mean change±SD in body weight from the end of the run-in to the end of the test period were not significantly different among the three groups: 0.4±1.0 kg (range, −1.9–2.5) in the boiled-coffee group, 0.2±1.8 kg (range, −6.3–3.0) in the boiled-and-filtered-coffee group, and 0.6±1.7 kg (range, −2.9–5.6) in the no-coffee group.

Results

Ambulant Blood Pressure and Heart Rate

The courses of the mean ambulant blood pressure and heart rate levels over time are shown in Figure 1. In the no-coffee group, mean ambulant systolic blood pressure fell by 2.0 mm Hg in comparison with the combined coffee drinking groups (95% confidence interval [CI] for difference with the pooled coffee groups, −4.0–0.0, $p=0.05$). The mean±SEM changes in diastolic blood pressure and heart rate in the no-coffee group compared with the coffee groups were small (−0.7±0.8 mm Hg and −0.5±0.9 beats/min, respectively) and insignificant. However, further analyses showed that the boiled-coffee group and the boiled-and-filtered-coffee group differed in their effects on systolic blood pressure. In the group drinking boiled coffee the mean ambulant systolic blood pressure rose by 3.1 mm Hg in comparison with the group drinking boiled-and-filtered coffee (Table 2; 95% CI for difference with the boiled-and-filtered-coffee group, 0.9–5.3, $p=0.006$). Compared with drinking boiled-and-filtered coffee, total elimination of coffee caused a small and insignificant fall of 0.4 mm Hg in systolic blood pressure (Table 2; 95% CI, −2.6–1.8). Thus, the mean difference of 2 mm Hg in systolic blood pressure between the combined-coffee group and the no-coffee group was due to higher levels in the boiled-coffee group only. Mean responses of ambulant diastolic blood pressure and of heart rate did not differ among the three groups (Table 2).

TABLE 2. Mean Effects of Consumption of Boiled Coffee, Boiled-and-Filtered Coffee, or No Coffee for a Period of 79 Days on Ambulant Blood Pressure and Heart Rate in 64 Healthy Volunteers

Variables	Boiled coffee (n=22)	Boiled-and-filtered coffee (n=21)	No coffee (n=21)
Systolic blood pressure (mm Hg)			
Run-in period	109.9±12.5	111.0±12.4	110.9±11.4
Test period	113.3±13.4	111.4±11.9	110.9±10.8
Change	3.5±4.1*	0.4±2.7	0.0±3.6
Diastolic blood pressure (mm Hg)			
Run-in period	68.9±7.7	70.5±7.6	70.0±6.6
Test period	70.2±8.1	71.1±8.1	70.3±6.6
Change	1.2±3.4	0.7±3.2	0.3±2.6
Heart rate (beats/min)			
Run-in period	61.5±8.5	69.0±8.6	65.2±7.6
Test period	63.3±8.1	70.0±10.1	66.1±8.8
Change	1.7±3.5	1.0±4.0	0.8±2.2

Values are mean effects ±SD.
*Denotes a significant difference with the group drinking boiled-and-filtered coffee, $p<0.025$.

TABLE 3. Mean Effects of Consumption of Boiled Coffee, Boiled-and-Filtered Coffee, or No Coffee for a Period of 79 Days on Hospital Blood Pressure and Heart Rate in 64 Healthy Volunteers

Variables	Boiled coffee (n=22)	Boiled-and-filtered coffee (n=21)	No coffee (n=21)
Systolic blood pressure (mm Hg)			
Run-in period	115.1±14.1	112.8±11.5	112.2±14.5
Test period	115.8±12.9	110.4±13.3	107.4±14.3
Change	0.6±5.7	−2.4±7.6	−4.7±6.2
Diastolic blood pressure (mm Hg)			
Run-in period	73.5±8.8	72.7±5.9	73.0±8.4
Test period	73.7±7.4	71.2±7.0	70.3±8.3
Change	0.3±4.3	−1.5±6.9	−2.7±4.2
Heart rate (beats/min)			
Run-in period	63.1±11.1	69.9±9.9	66.6±12.6
Test period	65.7±11.9	71.4±9.9	67.5±8.9
Change	2.6±6.0	1.5±6.7	0.9±6.9

Values are mean effects±SD. Hospital blood pressure was measured using a noninvasive automatic device (Arteriosonde 1225, Roche, Medical Electronic Division, Orangeburg, N.J.).

The rise in systolic blood pressure in the boiled-coffee group was significant ($p<0.025$) relative to the boiled-and-filtered-coffee group for the means of days 54–77, days 68–89, days 77–89, days 77–94, and also for the mean of all measurements made in the test period, with treatment effects ranging from 2.5 to 3.3 mm Hg. The response of ambulant systolic blood pressure to boiled coffee showed a tendency to be stronger for women than for men: the mean±SEM response relative to boiled and filtered coffee was 4.5±1.8 mm Hg for women and 1.7±1.2 mm Hg for men. However, neither this nor other responses differed significantly between men and women ($p>0.15$).

The responses of ambulant systolic and diastolic blood pressure to treatment were unrelated to baseline levels obtained during the run-in period. Baseline ambulant heart rate levels during the run-in period happened to differ among groups ($p<0.02$), but no correlation was found between the levels during the run-in period and the responses in heart rate during the test period. Analysis of the percent responses in heart rate showed the same results as analysis of the absolute responses.

Excluding the data of three subjects who had been ill or noncompliant (see "Methods") did not change the results: the mean difference in systolic blood pressure between the boiled-coffee and the boiled-and-filtered-coffee group now became 3.0 mm Hg (95% CI, 0.8–5.2, p=0.01). Adjustment for changes in body weight over the 11.5-week test period reduced the effect of boiled coffee on systolic blood pressure by 0.1 mm Hg and left all other differences insignificant.

Hospital Blood Pressure and Heart Rate

The differences in supine hospital blood pressure between groups paralleled those of the ambulant measurements (Table 3). Hospital blood pressure levels of the group drinking boiled-and-filtered coffee fell during the test period, even though their regimen was the same as that during the run-in period. We assume that this was a habituation effect taking place in all subjects. In the no-coffee group, systolic blood pressure fell by 3.9 mm Hg in comparison with the combined coffee groups (95% CI for difference with the pooled coffee groups, −7.4 to −0.5, p=0.03). The response of systolic blood pressure measured in the hospital was 3.1 mm Hg lower in the boiled-and-filtered-coffee than in the boiled-coffee group (Table 3; 95% CI, −7.0–0.8), which equals the difference in response measured with the ambulant recording. However, the treatment effect measured in the hospital was not significant due to the smaller number of measurements per subject. Elimination of coffee caused an insignificant fall in hospital systolic blood pressure of 2.3 mm Hg (Table 3; 95% CI, −6.2–1.6) compared with boiled and filtered coffee. As with the ambulant measurements, responses of diastolic blood pressure and heart rate did not differ among groups. Elimination of data of three subjects (see "Methods") and adjustment for changes in body weight did not influence the results.

After the study had ended, subjects resumed to their habitual consumption of drip-filtered coffee, and the ambulant blood pressure and heart rate levels returned to levels obtained during the run-in period, which had been measured with the same methodology (Figure 1).

Discussion

Coffee Brewing Method

Our results provide tentative evidence that boiled coffee raises systolic blood pressure compared with boiled-and-filtered coffee. Previous data on the relation between boiled coffee and blood pressure are scarce. An experiment of Bak and Grobbee[7] showed no effect on blood pressure in subjects who had been drinking 4–6 cups of boiled coffee for 9 weeks in comparison with subjects who had consumed drip-filtered coffee. Separate responses for men and women were not reported. In a cross-sectional epidemiological study from Norway, an inversely U-shaped relation was seen between systolic and diastolic blood pressure and the number of cups of drip-filtered and boiled coffee consumed. Within each consumption category, blood pressure levels were 0–2 mm Hg higher in those drinking boiled coffee compared with those drinking drip-filtered coffee.[18] We have now found that consumption of 6 cups boiled coffee/day caused a significant rise in mean ambulant systolic blood pressure of 3 mm Hg in comparison with consumption of boiled-and-filtered coffee. The rise tended to be higher in women than in men. The caffeine content of the boiled coffee was similar to that of the boiled and filtered coffee. Thus, there exists a possibility that boiled coffee might contain some other compound that raises systolic

blood pressure, a compound that was no longer present after filtration through paper filter.

Unfortunately, a blinded design of the study protocol was not possible, and consequently the results of our study must be interpreted with caution. However, apart from this inevitable imperfection, we successfully optimized the major methodological aspects, with treatment groups that were well-matched with respect to the most relevant baseline characteristics and with ruling out relevant changes in the diet or physical activity by evaluating all dietary recalls and all diaries. Since a higher potassium intake has even been reported to decrease blood pressure, the increase in potassium intake in the boiled coffee group can certainly not explain our observation.

Although several investigators have demonstrated that the pressor response to caffeine is comparable between normotensive and hypertensive subjects,[19,20] we are not aware of any data comparing the blood pressure–raising potential of boiled coffee between normotensive and hypertensive subjects. The current observations refer to normotensive subjects, and it remains to be established whether our results can be extrapolated to hypertensive subjects. Assuming that the pressor response to boiled coffee is similar in hypertension, the relevance of such a small increase in blood pressure is probably of minor importance in the management of individual patients with hypertension. Although the consumption of boiled coffee is declining now, it is still a common drink in several countries (Scandinavian countries, Turkey, Greece, and some countries from the Middle East), and therefore the excess risk associated with such a blood pressure–increasing factor in the population as a whole may well be of importance.[21]

Total Elimination of Coffee

Apart from studying the effects of different brewing methods, we also looked at the effects of total elimination of caffeine-containing coffee. We found that abstinence from coffee and tea for a period of 11 weeks had no effect on blood pressure or heart rate when compared with boiled and filtered coffee. This finding agrees with the results of previous experiments. In the aforementioned study of Bak and Grobbee,[7] refraining from drip-filtered coffee ingestion led to a fall in systolic blood pressure of 6.1 mm Hg after 9 weeks, but this was reduced to an insignificant effect of 3.4 mm Hg after adjustment for baseline levels and changes in body weight.[7] A second controlled trial showed a significant fall of 2.9 mm Hg in recumbent systolic blood pressure when subjects replaced regular instant coffee with tea, but the effect was reduced to an insignificant 1.3 mm Hg when blood pressure was measured in seated position.[8] Consistent with the findings of the experimental studies, some epidemiological studies found no differences in blood pressure levels between coffee users and coffee abstainers.[1,2]

In contrast to our findings on elimination of coffee, the aforementioned Norwegian cross-sectional study[18] found that persons not drinking coffee had slightly lower values for systolic and diastolic blood pressure than those drinking 1–4 cups of drip-filtered coffee. Likewise, Lang and coworkers[3,4] observed significant differences between French and Algerian coffee users and coffee abstainers in the order of 2–3 mm Hg, but no information on the brewing method had been recorded.[3,4] However, the absence of a significant effect of long-term abstinence from drip-filtered coffee and tea on blood pressure in the present study still leaves room for the possible existence of effects of 3 mm Hg or less. In a previous study we showed that drinking decaffeinated instead of regular drip-filtered coffee significantly decreased ambulant systolic and diastolic blood pressure by 1.5 and 1.0 mm Hg, respectively,[15] but the present study was not designed to pick up such small effects.

In conclusion, total elimination of drip-filtered coffee and of tea does not appear to have a substantial long-term effect on blood pressure or heart rate in healthy volunteers. However, boiled coffee not only raises serum lipids,[9–11] but it might also contain substances that raise systolic blood pressure. Both the blood pressure–elevating and the cholesterol-elevating effect of boiled coffee disappeared after filtration through paper filter.[12] Although the effect on systolic blood pressure was significant at the $p=0.006$ level, it still might be a chance observation, and it needs to be checked in future studies. Also, in future research on coffee and blood pressure the coffee preparation methods should be carefully documented.

Acknowledgments

We thank the volunteers for their cooperation and interest, and the dietitians Margreet A. Beerhorst, Saskia Meyboom, and Laura L. Verhaagen for conducting the interviews. Thanks are also due to the nursing and laboratory staff of the department for their assistance with blood sampling and analysis, and to Jan L. Harryvan (Agricultural University Wageningen, The Netherlands) for conducting the caffeine analysis.

References

1. Bertrand CA, Pomper I, Hillman G, Duffy JC, Mitchell I: No relation between coffee and blood pressure. *N Engl J Med* 1978;299:315–316
2. Dawber TR, Kannel WB, Gordon T: Coffee and cardiovascular disease: Observations from the Framingham Study. *N Engl J Med* 1974;291:871–874
3. Lang T, Degoulet P, Aime F, Fouriaud C, Jacquinet-Salord MC, Laprugne J, Main J, Oeconomos J, Phalente J, Prades A: Relation between coffee drinking and blood pressure: Analysis of 6,321 subjects in the Paris region. *Am J Cardiol* 1983;52: 1238–1242
4. Lang T, Bureau JF, Degoulet P, Salah H, Benattar C: Blood pressure, coffee, tea and tobacco consumption: An epidemiological study in Algiers. *Eur Heart J* 1983;4:602–607
5. Periti M, Salvaggio A, Quaglia G, Di Marzio L: Coffee consumption and blood pressure: An Italian study. *Clin Sci* 1987;72:443–447

6. Salvaggio A, Periti M, Miano L, Zambelli C: Association between habitual coffee consumption and blood pressure levels. *J Hypertens* 1990;8:585–590
7. Bak AAA, Grobbee DE: A randomized study on coffee and blood pressure. *J Hum Hypertens* 1990;4:259–264
8. Burr ML, Gallacher JEJ, Butland BK, Bolton CH, Downs LG: Coffee, blood pressure and plasma lipids: A randomized controlled trial. *Eur J Clin Nutr* 1989;43:477–483
9. Aro A, Tuomilehto J, Kostiainen E, Uusitalo U, Pietinen P: Boiled coffee increases serum low density lipoprotein concentration. *Metabolism* 1987;36:1027–1030
10. Bak AAA, Grobbee DE: The effect on serum cholesterol levels of coffee brewed by filtering or boiling. *N Engl J Med* 1989;321:1432–1437
11. Bønaa K, Arnesen E, Thelle DS, Førde OH: Coffee and cholesterol: Is it all in the brewing? The Tromsø study. *Br Med J [Clin Res]* 1988;297:1103–1104
12. Van Dusseldorp M, Katan MB, Van Vliet T, Demacker PNM, Stalenhoef AFH: The cholesterol-raising factor from boiled coffee does not pass a paper filter. *Arterioscler Thromb* 1991; 11:586–593
13. Tverdal A, Stensvold I, Solvoll K, Foss OP, Lund-Larsen P, Bjartveit K: Coffee consumption and death from coronary heart disease in middle aged Norwegian men and women. *Br Med J [Clin Res]* 1990;300:566–569
14. Vereniging van Nederlandse koffiebranders en theepakkers. Jaarverslag 1990. Amsterdam, Vereniging van Nederlandse koffiebranders en theepakkers, 1991, p 25 (Association of the Dutch Coffee Toasters and Tea Packers. Annual report 1990. Amsterdam, Association of Dutch Coffee Toasters and Tea Packers, 1991, p 25)
15. Van Dusseldorp M, Smits P, Thien Th, Katan MB: Effect of decaffeinated versus regular coffee on blood pressure: A 12-week, double-blind trial. *Hypertension* 1989;14:563–569
16. Smits P, Hoffmann H, Thien Th, Houben H, van't Laar A: Hemodynamic and humoral effects of coffee after β1-selective and nonselective β-blockade. *Clin Pharmacol Ther* 1983;34: 153–158
17. SAS Institute: *SAS User's Guide: Statistics,* ed 5. Cary, NC, SAS Institute Inc, 1985
18. Stensvold I, Tverdal A, Foss OP: The effect of coffee on blood lipids and blood pressure: Results from a Norwegian cross-sectional study, men and women, 40–42 years. *J Clin Epidemiol* 1989;42:877–884
19. Robertson D, Hollister AS, Kincaid D, Workman R, Goldberg MR, Tung C, Smith B: Caffeine and hypertension. *Am J Med* 1984;77:54–60
20. Smits P, Pieters G, Thien Th: The role of epinephrine in the circulatory effects of coffee. *Clin Pharmacol Ther* 1986;40: 431–437
21. Rose J: Strategy of prevention: Lessons from cardiovascular disease. *Br Med J* 1981;282:1847–1851

KEY WORDS • coffee • blood pressure • heart rate • clinical trials