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Do Whole-Grain Oat Cereals Reduce the Need for Antihypertensive Medications and Improve Blood Pressure Control?

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■ OBJECTIVES Our study compared 2 whole grain oat–based cereals with 2 refined grain wheat–based cereals to determine their effects on the need for antihypertensive medications in people with high blood pressure (BP).

■ STUDY DESIGN This 12-week, randomized controlled parallel-group trial with ≥ 6 weeks of voluntary follow-up was designed to investigate the antihypertensive effects of oats. After 4 weeks of baseline feeding, medication dose was maintained or reduced by half or completely throughout the middle 4 weeks of the study. In the final 4 weeks, participants continued cereal consumption; medication was adjusted according to the protocol.

■ POPULATION Men and women (n = 88) being treated for hypertension with a mean baseline BP below 160/100.

■ OUTCOMES MEASURED Primary study outcomes included change in SBP and DBP as well as antihypertensive medication reduction. Secondary measures included blood lipid, fasting glucose, and insulin levels and side effects related to elevated BP and increased dietary fiber intake.

■ RESULTS Seventy-three percent of participants in the oats group versus 42% in the control group were able to stop or reduce their medication by half. Treatment group participants whose medication was not reduced had substantial decreases in BP. The oats group experienced a 24.2–mg/dL reduction in total cholesterol levels, a 16.2–mg/dL decrease in low-density lipoprotein cholesterol levels, and a 15.03–mg/dL drop in plasma glucose levels vs controls.

■ CONCLUSIONS Results suggest that a diet containing soluble fiber–rich whole oats can significantly reduce the need for antihypertensive medication and improve BP control. Considering the lipid and glucose improvements as well, increased consumption of whole oats may significantly reduce cardiovascular disease risk.

KEY POINTS FOR CLINICIANS

- Whole oats, when supplemented daily, significantly reduced antihypertensive medication need and improved blood pressure control over the 12-week intervention.
- Whole oats improved blood lipid and fasting glucose levels and reduced the incidence of overall study-related side effects.
- Significantly increasing whole oat consumption may greatly reduce risk for cardiovascular disease in hypertensive patients.

■ KEY WORDS Hypertension; antihypertensive medication; whole grain [non-MeSH]; soluble fiber [non-MeSH]; oats. (*J Fam Pract 2002; 51:353-359*)

Since the initial use of antihypertensive medications in the 1940s, they have been the traditional approach to treatment essential hypertension. Many of these pharmacologic agents, however, are costly and are associated with substantial adverse effects. As a result, interest has been increasing in alternative methods to prevent and treat hypertension. Clinical trials using dietary interventions for the alleviation of hypertension and observational studies have suggested that a number of foods and specific food components may exert an antihypertensive effect.[1-5] Other

EXCLUSION CRITERIA

- History of systolic blood pressure > 180 mm Hg or diastolic blood pressure > 115 mm Hg (self-report during telephone screening)
- History of existing complications of hypertension, especially myocardial infarction, angina pectoris, cerebrovascular events, or impaired renal function
- History of major intestinal surgeries, malabsorption, stenosis of the gastrointestinal tract, or biliary disease
- Use of β-adrenergic receptor blocking agents
- Diabetes mellitus
- Body mass index > 35
- History or signs of excessive use of alcohol (> 2 drinks/day)
- Current smoking
- High soluble fiber intake (> 6 g/day)
- Chronic use of antacids, bulk laxatives, or other medications affecting gastrointestinal tract
- Continuous treatment with estrogen replacements at dosage > 2 mg or unstable dosage
- Participation in another intervention study 3 months before randomization

research, however, has shown no effect.[6-10] Studies specific to oats or cereal fibers have also provided mixed results. Observational studies have noted a reduction in blood pressure (BP),[11] but the few clinical trials conducted to date have shown no effect.[12]

Selected whole grains are known to be good sources of soluble fibers. Previous research trials have demonstrated that these fibers can effectively reduce plasma insulin concentrations and provide other health benefits.[13,14] Additionally, elevated insulin levels have been implicated in the etiology of hypertension.[15] Based on this potential biologic mechanism and the previously inconsistent findings, we conducted a 12-week trial to evaluate the clinical effects of soluble fiber–rich whole oat cereals when added to the diet of hyperinsulinemic patients medicated for essential hypertension.

METHODS

Study Sample

Participants were recruited from a database of treated hypertensive patients provided by a local health maintenance organization (HealthPartners). Initial letters describing the study were mailed to 8000 potential participants. Of these, 524 people responded to the mailing and agreed to a telephone screen to determine eligibility. Among respondents, 212 passed the initial phone screening and were invited to our research clinic (Hypertension and Cholesterol Research Clinic at the University of Minnesota Medical

School) for a BP screening and general physical. For inclusion in the study, average screening BP readings (2 sets of readings within 7 days) taken by our team physician could not exceed 160/100. Table 1 lists exclusion criteria. The study protocol was reviewed and approved by the University of Minnesota Human Subjects Committee of the Institutional Review Board.
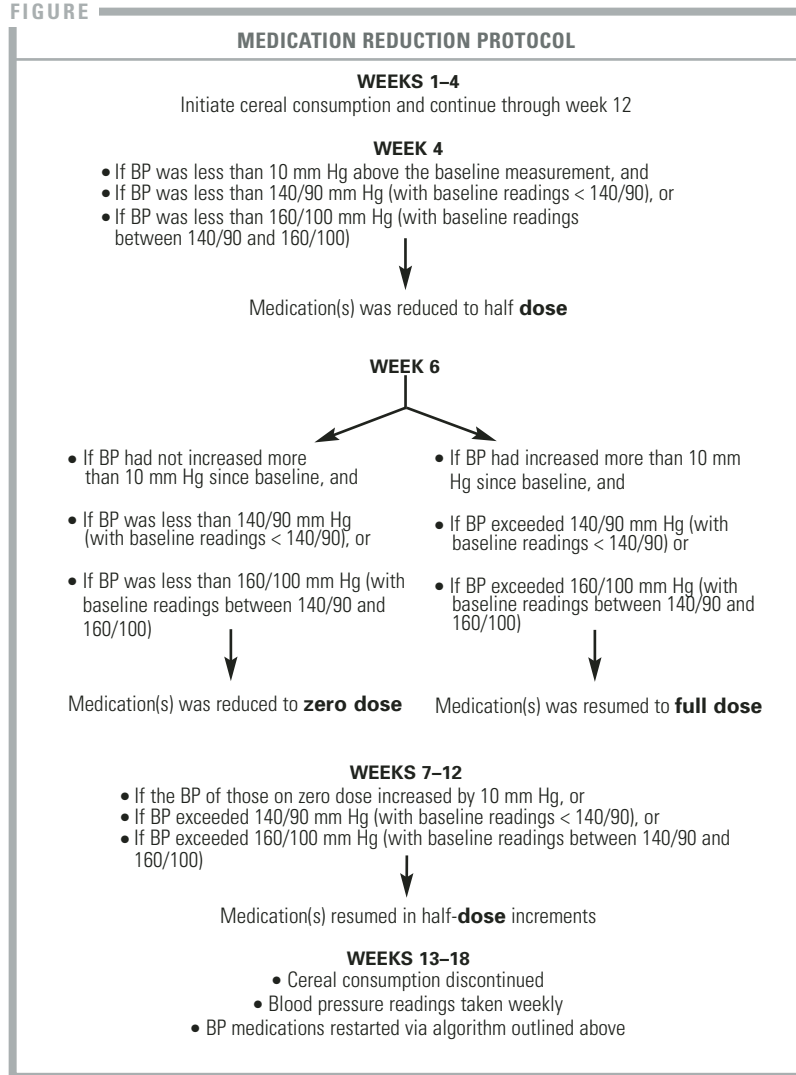
Eighty-eight volunteers (45 men and 43 women) aged 33 to 67 years met all inclusion criteria and provided written informed consent. All participants had a history of essential mild or moderate hypertension (BP 120/80 to 160/100 mm Hg), and were treated with no more than 1 antihypertensive medication (excluding β-adrenergic receptor blocking agents) and/or 1 diuretic medication for at least 1 month before enrollment. Eighty participants were treated with a single antihypertensive medication; 8 required an antihypertensive drug and a diuretic medication to manage their BP. Individuals taking beta blockers were excluded from the study because they often take medications prescribed for more serious cardiovascular conditions, such as cardiac arrhythmias, and medication reduction would be inappropriate under such circumstances. Participants' primary physicians were also consulted concerning participation and study-related medication changes.

Study Design

This randomized controlled parallel-group trial consisted of 3 four-week phases: a Baseline Feeding phase, a Medication Reduction phase, and a Maintenance phase. Eligible individuals were stratified by baseline systolic blood pressure (SBP) (< 140 mm Hg versus ≥ 140 mm Hg) and baseline soluble fiber intake (less than 3 grams/day versus 3 to 6 grams/day). At the start of the baseline phase, participants were randomized to either an oats cereal treatment group (n = 45) or a low-fiber cereal control group (n = 43).

The cereal treatments were isocaloric and administered during all 3 phases of the study. Individuals in the oats group received a daily serving of 60 grams (approximately three fourths cup) Quaker Oatmeal (5.61 grams total dietary fiber, 3.25 grams soluble fiber, and 2.83 grams β-glucans) and 77 grams (approximately one and one third cups) Quaker Oat Squares (6.07 grams total dietary fiber, 2.98 grams soluble fiber, and 2.59 grams β-glucans). Individuals in the control group consumed 65 grams (0.5 cup) Malt-O-Meal Hot Wheat Cereal (2.32 grams total dietary fiber, 0.6 grams soluble fiber) and 81 grams (2 cups) Kellogg's Crispix (1.2 grams total dietary fiber, < 0.5 grams soluble fiber).

FIGURE

MEDICATION REDUCTION PROTOCOL

WEEKS 1–4
Initiate cereal consumption and continue through week 12

WEEK 4
• If BP was less than 10 mm Hg above the baseline measurement, and
• If BP was less than 140/90 mm Hg (with baseline readings < 140/90), or
• If BP was less than 160/100 mm Hg (with baseline readings between 140/90 and 160/100)

↓

Medication(s) was reduced to half **dose**

WEEK 6

• If BP had not increased more than 10 mm Hg since baseline, and

• If BP was less than 140/90 mm Hg (with baseline readings < 140/90), or

• If BP was less than 160/100 mm Hg (with baseline readings between 140/90 and 160/100)

↓

Medication(s) was reduced to **zero dose**

• If BP had increased more than 10 mm Hg since baseline, and

• If BP exceeded 140/90 mm Hg (with baseline readings < 140/90) or

• If BP exceeded 160/100 mm Hg (with baseline readings between 140/90 and 160/100)

↓

Medication(s) was resumed to **full dose**

WEEKS 7–12
• If the BP of those on zero dose increased by 10 mm Hg, or
• If BP exceeded 140/90 mm Hg (with baseline readings < 140/90), or
• If BP exceeded 160/100 mm Hg (with baseline readings between 140/90 and 160/100)

↓

Medication(s) resumed in half-**dose** increments

WEEKS 13–18
• Cereal consumption discontinued
• Blood pressure readings taken weekly
• BP medications restarted via algorithm outlined above

Cereals were dispensed in unlabeled bulk containers to facilitate physician blinding. Remaining cereal was returned and weighed at each of the weekly or biweekly visits at our research clinic. Additionally, participants kept a daily cereal calendar that was reviewed by members of our research staff and used to help determine cereal compliance.

Changes in antihypertensive medication dose were implemented according to the protocol described in the Figure. Participants were asked to maintain their usual lifestyle, physical activity, dietary pattern, and body weight during the 12 weeks of the study. Individuals were invited to participate in a 6-week follow-up phase after the intervention was completed to monitor the residual BP effect after cereal consumption was discontinued.

Outcomes Measured

The study physician responsible for BP measurement, blood draws, and general patient examinations

(described below) was unaware of the cereal group assignment. BP was measured at the clinic twice a week during the first (baseline feeding) and last (maintenance) phases of the study and weekly during the second (medication reduction) phase. Participants reported at approximately the same time of the day for all appointments. BP readings were obtained 24 hours after the last medication dose or, if the patient was unmedicated, at the same time of day as previous study BP readings and after participants had rested quietly in the seated position for at least 5 minutes in an examination room.

The study physician took all readings on the right arm, using a mercury column sphygmomanometer (Korotkoff phase V for diastolic blood pressure [DBP]). Standard cuff size was used unless upper arm circumference exceeded 31 cm, in which case a large cuff with 15 x 35–cm bladders was chosen. Measurements were repeated 4 times in 2-minute intervals. The mean of the last 3 readings was calculated and used in subsequent analyses. Baseline and final study measurements used in the analyses and reported in this paper represent the averages of the first 2 and last 2 study visits.

Preintervention and postintervention blood samples were collected into standard 6-mL serum separator tubes. Samples were analyzed within 24 hours for general chemistry and plasma lipids (total cholesterol, low-density cholesterol [LDL-C], and high-density cholesterol [HDL-C] as well as triglyceride levels) by an accredited independent laboratory and according to standard chemical methods.[16]

A written 42-question side effect questionnaire was administered to participants at the beginning of the baseline phase and at the end of the intervention. Participants reported the frequency with which they experienced side effects associated with increased fiber intake (eg, loose stools, flatulence) and hypertension (eg, headaches, dizziness) using a 5-item scale ranging from "never" to "very frequently" (event occurring once or several times daily).

BASELINE CHARACTERISTICS*		
	Oats Group (n = 45)	Control Group (n = 43)
Sex (M/F)	23/22	22/21
Race (% Caucasian)	96	98
BMI (kg/m²)	31.2 ± 5.1	30.6 ± 4.7
Age (years)	48.7 ± 16.9	46.4 ± 15.3
LDL-C (mg/dL)	139.2 ± 29.3	137.7 ± 27.5
HDL-C (mg/dL)	43.1 ± 9.1	44.2 ± 10.2
TC (mg/dL)	211.6 ± 38.6	213.7 ± 42.3
SBP (mm Hg)	140 ± 16	138 ± 15
DBP (mm Hg)	88 ± 10	86 ± 9
TG (mg/dL)	185.4 ± 40.2	191.6 ± 41.9
Insulin (µU/mL)	16.9 ± 6.1	15.2 ± 5.9
Soluble fiber (g)	5.3 ± 1.6	4.8 ± 1.3

BMI denotes body mass index; DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; SBP, systolic blood pressure; SD, standard deviation; TC, total cholesterol; TG, triglycerides.

* Values are means ± SD; means did not differ significantly.

Each item of the scale was assigned a value ranging from 1 to 5. Values were tallied across all 42 questions. A final score was assigned to each participant for both time points. Mean scores by group were used in the analyses.

Participants completed a 3-day food record at baseline and at the end of the 12 weeks of intervention. Food records were examined for thoroughness by a licensed nutritionist and used to determine dietary changes. Nutrient intakes were calculated using the Nutrient Data System software (version 2.92) managed by the Nutrition Coordinating Center at the University of Minnesota School of Public Health.[17] For baseline and post study micronutrient and macronutrient intake by group, see Table W1.*

Statistics

The sample size calculation was based on a level of significance set at 0.05 and power at 80% to detect a 15% difference in medication reduction. Differences in medication reduction were determined by using the chi-square test of proportions. For continuous variables, Student's paired and unpaired t tests were performed to determine differences within and between groups. In terms of medication reduction, logistic regression was

* Table W1 can be found on the JFP Web site, www.jfponline.com.

used to adjust for potential confounders such as body weight and sodium intake. Multiple regression was employed to adjust blood lipid and glucose levels and BP findings for confounding. Because adjustment did not change the interpretation of the data, unadjusted findings are reported. The analyses of the data from this intent-to-treat population, which were determined to include all randomized patients, were conducted using the Statistical Analysis System (SAS Institute, Cary, N.C.). Results are reported as means ± SD unless noted otherwise. All P values are double sided.

RESULTS

All the original 88 participants enrolled, all completed the 12-week trial, and all participated in the 6-week follow-up phase. Instructions to consume all dispensed cereals every day were followed well. Compliance was high for both groups (94.5% for the oat group and 92.7% for the control group) based on the amount of consumed cereal by weight. Randomization was largely effective; there were no apparent differences in baseline characteristics between each of the treatment groups (Table 2). Participants were primarily white (97%), with a mean age of 48 years (range 33 to 67 years).

BP and BP medication changes are summarized in Table 3. Among subjects in the oats group, 73% experienced a BP medication reduction during the intervention and had maintained that by the end of the study, as compared with only 42% in the control group (P < .05). Moreover, those in the oats group who did not experience a medication reduction had a 7-mm Hg decrease in SBP and a 4-mm Hg reduction in DBP. There was a small, nonsignificant change in SBP and DBP among those who did not experience a medication reduction in the control group. Medication reduction did not differ across

ANTIHYPERTENSIVE MEDICATION AND BLOOD PRESSURE CHANGES BY GROUP			
	Oats Group (n = 45)	Control Group (n = 43)	P *
BP medication reduction, n (%)	33 (73%)	18 (42%)	<.05
BP changes in those without medication reduction (post treatment, baseline)†			
SBP in mm Hg	-7 ± 8	-1 ± 9	<.05
DBP in mm Hg	-4 ± 5	1 ± 6	.18
BP medication resumption, n (%)	23/33 (67%)	6/18 (33%)	<.05

*P < .05 between oats and control groups.
† Values are means ± SD.
SBP denotes systolic blood pressure; SD, standard deviation; DBP, diastolic blood pressure.

classes of antihypertensive medication or our stratification variables of baseline soluble fiber intake or BP. Additionally, during the 6-week follow-up phase, 6 of the 18 (33%) individuals in the control group versus 22 of the 33 (67%) in the treatment group resumed taking medication.

Average BP in the oats group was lowered from 140/88 mm Hg at baseline to 134/85 mm Hg by the end of the first 4 weeks. Only the change in systolic BP was statistically significant ($P < .05$). Over the same 4-week period, the control group experienced a mean change of BP from 138/86 mm Hg to 136/85 mm Hg, which was not significant.

Baseline and postintervention lipid and glucose levels appear in Table 4. There were no significant modifications in any of the lipid parameters for the individuals in the control group, although there was a downward trend in all lipid measures. In the oats treatment group, mean total cholesterol (TC) concentration decreased by 31.7 mg/dL (15% drop). A similar decrease of 22.3 mg/dL (16% drop) was seen in the oats group's average LDL-C levels. Blood glucose levels in the oats group also improved significantly ($P < .01$). The mean differences between post study and prestudy values (± SE) between the 2 groups, calculated for the average changes in TC, LDL-C, and glucose experienced by each of the groups, were -24.2 mg/dL (± 6.1), -16.2 mg/dL (± 4.4), and -15.03 mg/dL (± 4.3), respectively.

The frequency of dietary fiber-related and hypertension-related side effects decreased by 22% in the treatment group (Table 4). This finding was not observed in the control group. No weight changes were observed in either group, indicating that participants adjusted their diet to compensate for the addition of the cereals by substituting cereal for their standard breakfast and consuming them in place of afternoon snacks as determined by the food record

inspection. As shown in Table W1 (see http:// www.jfponline.com), total daily energy intake (kcal/day) remained virtually unchanged when postintervention food intake was compared with intake at baseline. Participants in both groups did experience significant decreases in total fat and saturated fat intake along with significant increases in fiber (both soluble and insoluble), potassium, and calcium. The increase in total fiber intake was greater in the treatment group ($P < .01$) than in the control group ($P < .05$). In addition, the treatment group experienced a significant increase in magnesium not observed in the control group.

DISCUSSION

The results of this trial suggest that an increased consumption of soluble fiber-rich, whole-grain, oat-based cereals can significantly reduce antihypertensive medication need among patients being treated for hypertension. Of the 45 participants in the oats group, 33 experienced at least half medication reduction compared with only 18 of the 43 participants in the control group. Positive BP changes were evident during the first 4 weeks of oat cereal treatment; BP levels rose steadily during the 6-week follow-up phase.

In addition, mean BP readings in the oat group participants who did not experience a medication reduction had improved at study completion compared with baseline. A significant number of participants in the refined cereal control group experienced at least half medication reduction (18/43), a finding that might be attributed to the increase in calcium, potassium, and total dietary fiber intake[8,9,18] as well as to the decreased intake of total and saturated fat.[19] Additionally, during the follow-up phase, only 6 of the 18 (33%) versus 22 of the 33 (67%) in the oats group resumed taking their medication. Therefore, part of the medication reduction effect in

TABLE 4

SECONDARY OUTCOME MEASURES BY GROUP*

	Oats Group		Control Group	
	Baseline	**Post Study**	**Baseline**	**Post Study**
Total cholesterol (mg/dL)[†]	211.6 ± 5.9	179.9 ± 5.2	213.7 ± 6.7	206.2 ± 6.5
LDL cholesterol (mg/dL)[†]	139.2 ± 4.5	116.9 ± 4.2	137.7 ± 4.4	131.6 ± 4.7
HDL cholesterol (mg/dL)	43.1 ± 1.4	44.6 ± 1.7	44.2 ± 1.6	43.2 ± 1.5
Triglycerides (mg/dL)	185.4 ± 6.2	172.6 ± 6.5	191.6 ± 6.4	184.2 ± 6.8
Glucose (mg/dL)[†]	118.4 ± 4.1	106.1 ± 4.2	117.1 ± 5.2	119.8 ± 5.5
Side effects (score)[†]	58.2 ± 7.2	47.6 ± 6.9	56.7 ± 8.1	53.4 ± 7.2
Weight (kg)	82.5 ± 5.5	83 ± 5.9	83.7 ± 5.3	83.4 ± 5.8

*Values are means ± SEM except for body weight, which is represented as mean ± SD for all participants.

[†]Indicates statistical differences between groups (change score) at $P < .05$.

the control group may have been the result of a greater percentage of participants who did not need their antihypertensive medication. This issue should be considered in the design of future trials.

As always, regression to the mean and the Hawthorne effect might explain some of the outcomes in this trial. However, it is likely that both increased soluble fiber and micronutrient intake explain the decrease in antihypertensive medication need observed in the treatment group. This study was designed to identify not the hypotensive effects of specific cereal components but the effects of a whole food intervention. Our findings are consistent with those of other whole-food interventions, such as the Dietary Approaches to Stop Hypertension (DASH) trial, tested in hypertensive populations.[20] Nonethe-less, known diet-related determinants of BP (sodium chloride, alcohol, body weight, and level of physical activity) could not explain the treatment effect because no significant differences in these variables existed between the groups.

The soluble fiber fraction of the oat-based cereal intervention is probably partially responsible for the reduction in antihypertensive medication need observed in this trial. Previous studies that tested either soluble fiber supplements or diets rich in soluble fiber have noted significant reductions in BP.[21-23] Improvement in insulin sensitivity has been proposed as the pathway through which soluble fiber improves BP.[24] Insulin sensitivity was not determined in this study, yet the oats treatment group experienced a significant improvement in plasma glucose levels. This finding suggests that insulin sensitivity may have been enhanced. Impaired response to insulin was recently shown to precede endothelial dysfunction and subsequent elevations in BP.[25] Moreover, soluble fiber supplements and diets high in soluble fiber have been shown to improve insulin sensitivity.[25-28] Other components of whole grains, such as magnesium or grain flavonoids, may also contribute to the favorable medication reduction observed in the oats group.[29,30]

This 12-week whole-food intervention trial was not designed to test either the long-term efficacy of oat-based cereals or the likelihood of long-term adherence to the feeding regimen. Nonetheless, a whole-grain oat-based cereal intervention might be an effective way to manage mild (type I) hypertension. The reduction in BP medication that occurred in the oats group was independent of weight change and sodium chloride and alcohol intake, suggesting that soluble fiber–rich whole grains should be added to the current dietary recommendations for people with elevated BP. Moreover, it is possible that the consumption of a diet high in soluble fiber–rich whole grains may prevent or delay the initiation of hypertension drug therapy in at-risk or borderline hypertensive patients. Based on the results from this study, physicians may be justified in recommending to their hypertensive patients a dietary regimen that includes the daily consumption of whole-grain oats (equaling 6 g of soluble fiber) in conjunction with their usual therapy. Such an intervention may be expected to yield results within 4 weeks.

CONCLUSIONS

A diet containing soluble fiber-rich whole grains can significantly reduce antihypertensive medication need and improve BP control among treated hypertensives. Combined with the reductions in blood lipids and plasma glucose, the intake of soluble fiber–rich whole oat cereals appears to be an effective nutritional approach in the reduction of cardiovascular disease risk. Future trials will need to investigate the antihypertensive effects of oats in other populations (eg, different racial groups) and determine whether reductions in BP measurements can be sustained for the long term.

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