Published in final edited form as:
J Am Diet Assoc. 2010 February ; 110(2): 291–295. doi:10.1016/j.jada.2009.10.041.

Factors Influencing Dietary protein sources in the PREMIER trial population

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Abstract

Previous research suggests that protein intake, particularly plant protein, may benefit blood pressure (BP) control. However, very little has been published regarding protein sources in diets of the US adults and factors influencing these choices. The purpose of this report is to describe specific sources of animal and plant proteins in diets of PREMIER clinical trial participants at baseline and how the PREMIER intervention, along with participant demographics, affected protein sources. Adult participants (n=809) who completed the 18-month PREMIER lifestyle intervention trial and had at least one diet recall at each of three study visits were included. Participants were recruited from four clinical centers in the Eastern, Southern and Northeastern regions of US. The PREMIER trial, conducted from 1999 to 2002, compared the impact on BP of two structured behavioral interventions focusing on the traditional lifestyle modifications for BP control with or without the Dietary Approaches to Stop Hypertension (DASH) dietary pattern. Protein sources were assessed by two unannounced 24 hour recalls at each of three study visits. Differences in protein sources were mainly related to participant demographics, with relatively moderate impact of the intervention. The top four protein sources for all the study participants were poultry, dairy, refined grains and beef, each contributing approximately 10–17% in descending order to the total protein intake at baseline. Animal and plant protein each comprised approximately 66% and 34%, respectively, to the total daily protein intake at baseline and such overall contribution pattern remained relatively constant over time. However, gender, race, age and body weight status all influenced contribution patterns from different food groups significantly. These influences significantly impact choice and are essential elements to consider when designing intervention programs to alter protein contributions from animal versus plant sources.

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Keywords

animal protein; plant protein; protein sources; lifestyle intervention

Introduction

Dietary intake affects blood pressure (BP) and many large clinical trials have proven the impact of dietary modification on BP (1–6). However, identifying the exact nutrient or food item that benefits BP control can be challenging. Accumulating research studies show that different types of protein affect BP differently and particularly, plant protein may benefit BP control (7–13). Very few studies have examined the food sources of different types of protein or how a lifestyle intervention program or participant demographics may affect protein sources. Thus, the purpose of this report is to identify types of protein in the diets of the PREMIER participants and their respective food sources. This information may be helpful for future intervention programs that desire to modify types and amounts of dietary protein consumption to exert positive changes on BP.

Methods

Study design

PREMIER was a randomized clinical trial conducted during 1999 and 2002, designed to determine the effects of two multi-component lifestyle interventions on BP. Detailed description of the study design, intervention programs and main results were published elsewhere (14,15). Participating institutions included four clinical centers (Duke University Medical Center, Durham, NC; Johns Hopkins University, Baltimore, MD; Pennington Biomedical Research Center, Baton Rouge, LA; and Kaiser Permanente Center for Health Research, Portland, OR), and the Coordinating Center (Kaiser Permanente Center for Health Research, with funding by NHLBI (Bethesda, MD). Each center's institutional review board and an external protocol review committee approved the protocol. Participants provided written informed consent. After a series of screening visits, participants with above optimal BP (120–139/80–89 mmHg) or with stage 1 hypertension (140–159/90–95 mmHg) were randomized to: 1) a behavioral lifestyle intervention that implemented established recommendations for BP control (EST), 2) a behavioral lifestyle intervention that implemented established recommendations plus the Dietary Approaches to Stop Hypertension (DASH) dietary pattern (EST+DASH), or 3) an advice only control group (control), for an 18 month period.

Study Participants

A total of 810 participants were randomized into the study. Individuals were eligible if they were not taking anti-hypertensive medication, had a systolic BP of 120–159 mmHg and diastolic BP of 80–95 mmHg. Other inclusion criteria were age 25 or older and BMI 18.5–45.0 kg/m^2. Major exclusion criteria were regular use of drugs that affect BP, JNC-VI (Sixth report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure) risk category C (target organ damage and/or diabetes), use of weight-loss medications, prior cardiovascular event, heart failure, angina, cancer diagnosis or treatment in the past two years, consumption of > 21 alcoholic drinks/week, and pregnancy, planned pregnancy, or lactation.

Intervention

Both EST and EST+DASH participants received weekly group sessions for the first eight weeks, then bi-weekly for the remainder of the first six months and monthly for the last 12 months. Seven individual sessions were interspersed throughout the 18 months. Intervention sessions lasted approximately two hours, were conducted mainly in discussion format, interactive style and included hands on activities and discussion. Trained interventionists, generally registered dietitians or nutritionists, conducted intervention sessions. All interventionists received central training annually focused on motivational interviewing and completed a certification process.

During the intervention, participants' goals for both the EST and EST+DASH interventions were at least 6.8 kg (15 lb) weight loss at six months for those with a BMI ≥ 25 kg/m^2, at least 180 minutes/wk of moderate-intensity physical activity, no more than 100 mmol/d (2300 mg/d) of dietary sodium, and no more than two alcoholic drinks/day for men and one drink/day for women (16). Additionally, individuals in the EST+DASH intervention were counseled to implement the DASH dietary pattern, including: nine to 12 daily servings of fruits and vegetables, two to three servings of low-fat dairy products daily, and intake of total and saturated fat of no more than 25% and 7% of total calories, respectively.

In contrast, the control group received advice in a single 30-minute individual session at randomization, which included written materials on established recommendations for BP control and DASH dietary pattern. No behavioral counseling or further intervention contact was provided until completion of the six-month data collection visit when participants received another similar 30-minute advice-only session.

Measurements

All measurements were obtained at baseline, six and 18 months after randomization by staff blinded to randomization assignment. Nutrient and food group intake were assessed from unannounced 24-hr dietary recalls conducted by telephone. Two recalls were collected by the Diet Assessment Center, Pennsylvania State University at each study time point (one weekday and one weekend-day, non-consecutive) with food information calculated using the Nutrition Data System for Research (NDSR, version 1998, Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN). Percent contribution of animal and plant protein to daily total protein intake was calculated. A total of 32 food groups were derived from the NDSR database based on USDA's food grouping system, and included fruits, fruit-based snack, vegetables, vegetable-based snack, whole grain, refined grain, dairy, dairy-based dessert, nut/seed, fats, beef, pork, poultry, lamb, etc. Mixed dishes were separated into ingredient components first and then assigned to the appropriate food group. Across the four sites, completion rate of the diet recall averaged about 90% at six and 18 months. Mean of the two recalls at each time point was used for analysis.

Statistical analysis

All analyses were conducted using SAS software (version 9.1, 2002–2003, SAS Institute Inc., Cary, NC). Among the total of 810 randomized participants, no diet recall was collected from one participant, thus a total of 809 participants had both diet recalls at one or more time points. However, participants missed diet recalls at different time points and thus the final numbers of participant with both diet recalls at baseline, six and 18 month were 806, 706 and 727, respectively. Analyses were conducted separately for each food group and outcome category (daily animal protein, and plant protein intake). Since measurements were taken at three time points (baseline, six, and 18 months), independent variables including effect of treatment, time, and potential confounders such as age (at baseline), race, gender, and weight (at respective time points) were incorporated in the mixed model analyses. Due to multiple comparisons across the 32 food groups included, Bonferroni correction was performed to compensate for multiple testing and thus the significance level was set at 0.0015. All data are presented as mean or Least Square of Mean ± SD.

Results and Discussion

Among the 809 participants in this study, 62% were female, 64% Caucasian American and 34% African American. At baseline, participants averaged 50.0 ± 8.5 years of age and were generally overweight (BMI: 33±6 Kg/m^2), the majority had some college education and were middle class. In general, participants followed intervention guidelines, making dietary changes in expected directions (17). Consumption of red meats, fats, sweets, sweetened drinks, cream and dressings and refined grains decreased, however, consumption of fruits, vegetables, dairy and poultry increased. The changes mainly occurred among EST+DASH participants and to a lesser degree among EST participants. Gender, racial background, age and body weight also influenced contribution patterns toward protein intakes for certain food groups.

At baseline, participants consumed an average of 16.1%±5.3 kcal as protein which was contributed by approximately 66% animal protein and 34% plant protein. The energy contribution from total protein increased slightly over time to either 17% (control group) or 18% (EST and EST+DASH groups). The top four protein sources were poultry, dairy, refined grains and beef, each contributing approximately 10–17% in descending order to the total protein intake at baseline. The top four protein sources remained unchanged over time for all treatment groups. Even though the daily contribution of animal and plant proteins to total protein intake was unchanged over time, the contribution from different food groups changed.

Overall, after incorporating all potential confounders, dairy was the only food group that showed a change in contribution to animal protein due to treatment ($p<0.0015$)(Table 1). Racial background also affected the contribution of animal protein from seafood, beef, dairy and poultry (all $p<0.0015$). On average, Caucasian American participants consumed more animal protein from beef (11.5±0.4% vs 8.3±0.6%) and dairy (19.2±0.4% vs 11.2±0.5%), less from seafood (6.7±0.3% vs 9.0 ±0.5%) and poultry (15.3±0.5% vs 25.3±0.7%) than African American participants. Body weight only affected animal protein contribution by beef, with heavier participants having more beef contributed to animal protein intake (β: 0.04, $p<0.0001$).

It should be noted that the food groups listed in tables 1 and 2 are not classified as either plant or animal protein. Food groups were listed to show how much plant or animal protein each food group contributed to the daily total intake of protein. For example, the sweets food group listed in Table 2 was not classified as a plant protein, it was included because it contributed some plant protein to the total protein intakes.

Very little has been published regarding consumption of different types of protein. Smit el al noted somewhat similar consumption patterns of animal and plant protein in US adults (18). Using National Health and Nutrition Examination Survey III (NHANES III) data, these investigators reported that animal protein contributed 69% of total protein intake, similar to our population who consumed 66%. The PREMIER population consumed less red meat and more poultry compared to the NHANES III population. In addition, dairy intake was lower among PREMIER participants at baseline compared to the NHANES III population. These differences may be related to the fact that African-American participants, who were over-represented in the PREMIER population, consumed less beef, dairy and more poultry than Caucasian-American participants did.

The contribution of plant protein from refined grains, vegetables, fruits and sweets (including desserts that might contain protein sources such as flour, fruits, dairy and egg) were significantly affected by treatment (all $p<0.0015$), with the EST+DASH group having the greatest reduction in refined grains and increases from fruit at follow up (Table 2). There was also a significant age effect with older participants more likely to consume greater amounts of whole grains (β: 0.06, $p=0.0009$) and fruit (β: 0.04, $p<0.0001$) and lesser amounts of refined grains (β: −0.07, $p=0.0007$). In addition, body weight significantly affected the plant protein contribution by nut/seed, fruits and vegetables. Heavier participants had smaller plant protein contribution from nut/seed (β: −0.013, p=0.0014), fruits (β: −0.01, p<0.0001) and vegetables (β: −0.02, p<0.0001).

Total intake of plant protein and contribution patterns from different food groups were somewhat similar between PREMIER and NHANES III populations (18), except that vegetables contributed slightly less to total plant protein intake in PREMIER participants at baseline compared to NHANES III. The contributions of vegetables to plant protein intakes in PREMIER and NHANES III were approximately 6% and 8% (data not shown), respectively. Since a formal comparison test was not feasible with these data, it is unclear if this difference was significant statistically or simply due to chance. Contributions from whole and refined grains were not reported for the NHANES III, thus, it remains unclear how this pattern may have differed from PREMIER participants.

Although intake of total protein appears similar between Caucasian- and African-American populations (19), sources differed. African-American participants consumed more poultry and seafood but less dairy and beef. Dairy intake findings are consistent with previous findings from NHANES III (19), suggesting possible influences of cultural background, economics, taste preference and perhaps other factors. A recent study of over a million older Americans in the National Institutes of Health-AARP Diet and Health study reported that consumption of red meat increased total mortality while white meat had the opposite influence (20). Thus, health impact of different protein source deserves further examination.

The impact of age on protein source patterns observed in PREMIER is consistent with findings from a report reviewing multiple large scale studies (21). This report indicated that older people, particularly women, tended to consume healthier diets with higher intakes of fruits, vegetables and vitamins A, C and potassium than their younger counterparts. Older participants in PREMIER also seemed to follow healthier patterns by consuming greater amounts of whole grains, fruits, vegetables and nuts/seeds.

Findings on the influence of body weight on patterns of protein intakes are similar to that observed among NHANES III population (22). Using NHANES III data, Kant (22) reported that higher energy dense diets are characterized by low fruit and vegetable intake and high BMI. Similar findings were observed in this study, the heavier the participants, the higher the tendency to consume more pork and beef and less fruits and vegetables which altogether contributes to a higher energy dense diet.

The limitations of this study include self-reported dietary intakes, lack of objective markers for intake of different protein sources, and a study population not entirely representative of the US population. However, the study population was adequately powered for the intended analyses. While PREMIER focused on strategies to achieve specific dietary targets, the protein sources information may warrant more intensive intervention efforts to change animal or plant protein sources. It is important when designing intervention programs to take into consideration the impact of these influences.

Conclusion

This report provides a detailed overview of contributions of animal and plant proteins by different food groups in PREMIER participants and points out substantial differences in protein sources due to gender, race, age and body weight status. Although the contribution of various food groups to the intakes of animal and plant proteins were affected by the PREMIER intervention, daily contribution of animal and plant proteins to total protein intake was unchanged. This finding is relevant to future dietary intervention programs, varying in design from experimental controlled feeding to behavioral intervention study, that plan to modify contribution of animal and/or plant protein intake. Intervention content and tools would need to be developed to better modify the absolute contributions of animal and plant protein. The health impact of differences in protein sources also deserves further investigation.

Acknowledgments

Supported by cooperative agreements from the National Heart, Lung, and Blood Institute: U01 HL60570, U01 HL60571, U01 HL60573, U01 HL60574, U01HL62828, and M01 RR00052.

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Table 1

Percent contribution of animal protein to daily total protein intake from food groups by time and treatment

% of daily total protein intake[a]	Control			Established			Established+DASH		
Unadjusted Mean (SD)	**Baseline**	**6 Month**	**18 Month**	**Baseline**	**6 Month**	**18 Month**	**Baseline**	**6 Month**	**18 Month**
EGGS	4.1 (4.7)	4.0 (4.9)	3.1 (4.0)	4.1 (5.1)	3.6 (5.0)	3.6 (4.5)	4.1 (4.9)	2.5 (4.1)	2.6 (4.0)
PORK	6.4 (9.2)	6.0 (9.5)	5.7 (9.3)	6.2 (9.4)	4.5 (8.4)	5.6 (9.4)	7.9 (11.5)	4.6 (8.3)	4.6 (8.9)
SEAFOOD[f]	7.4 (11.9)	7.8 (12.5)	7.4 (13.5)	7.0 (10.7)	8.8 (12.6)	7.7 (12.5)	6.8 (10.9)	7.5 (11.5)	6.7 (10.6)
BEEF[fg]	10.8 (13.1)	11.4 (14.4)	10.6 (13.4)	11.4 (14.2)	9.6 (12.6)	10.0 (13.9)	11.6 (13.2)	8.2 (11.9)	9.6 (13.4)
DAIRY[cf]	15.7 (10.7)	14.5 (11.5)	15.4 (10.7)	14.6 (10.2)	14.8 (11.6)	14.5 (12.8)	16.6 (11.1)	22.2 (11.7)	20.4 (13.4)
POULTRY[f]	17.2 (16.9)	17.7 (16.9)	19.7 (17.6)	19.5 (16.5)	19.8 (18.5)	21.5 (17.9)	16.1 (15.4)	18.5 (16.5)	19.6 (17.7)
SUM	64.6 (12.5)	65.6 (13.1)	65.7 (12.7)	66.3 (12.6)	65.1 (12.4)	66.7 (11.6)	66.3 (11.5)	67.2 (9.9)	66.2 (12.6)

Only food sources contributed >1% are listed.

[a]Values represent mean percent contribution from each food group to the daily total protein intakes.

[b]Significant effect in time,

[c]treatment,

[d]time x treatment interaction,

[e]gender,

[f]race, and

[g]weight from the mixed model analysis, $p<0.0015$.

Table 2

Percent contribution of plant protein to daily total protein intake from food groups by time and treatment

% of daily total protein intake[a]	Control			Established			Established+DASH		
Unadjusted Mean (SD)	**Baseline**	**6 Month**	**18 Month**	**Baseline**	**6 Month**	**18 Month**	**Baseline**	**6 Month**	**18 Month**
LEGUMES	1.3 (3.2)	0.6 (4.0)	0.4 (1.9)	1.1 (2.9)	0.3 (1.6)	0.5 (2.4)	1.2 (2.9)	0.1 (0.6)	0.4 (2.4)
SWEETS[c]	1.7 (2.3)	1.1 (1.8)	0.7 (1.9)	1.4 (2.3)	1.3 (2.0)	1.4 (2.1)	1.3 (2.2)	0.9 (1.6)	0.7 (1.3)
NUT/SEED[h]	1.8 (4.1)	1.3 (3.3)	1.7 (4.4)	1.7 (4.0)	1.6 (3.4)	1.9 (4.7)	2.0 (4.8)	1.1 (2.6)	1.7 (3.8)
FRUIT[cdgh]	2.1 (2.5)	2.4 (2.6)	2.3 (2.3)	1.9 (1.9)	2.7 (2.7)	2.5 (2.1)	1.8 (1.8)	4.6 (3.1)	4.0 (3.3)
WHOLE GRAINS[g]	4.3 (5.3)	4.1 (5.6)	4.1 (5.5)	3.7 (4.9)	5.3 (6.4)	4.1 (5.4)	3.6 (5.1)	4.6 (5.0)	3.7 (4.3)
VEGETABLES[h]	6.0 (4.4)	7.5 (5.5)	7.4 (5.8)	6.2 (4.3)	7.8 (5.5)	7.0 (5.3)	5.9 (3.7)	8.3 (5.4)	9.0 (5.6)
REFINED GRAINS[cdg]	14.7 (7.4)	13.9 (9.1)	13.5 (7.7)	14.5 (7.4)	12.9 (7.5)	12.6 (6.7)	14.5 (6.9)	10.3 (6.3)	11.3 (7.5)
SUM	35.2 (12.5)	34.2 (13.0)	34.1 (12.5)	33.5 (12.6)	34.8 (12.3)	33.1 (11.6)	33.5 (11.5)	32.8 (9.9)	33.7 (12.6)

Only food sources contributed >1% are listed.

[a] Values represent mean percent contribution from each food group to the daily total protein intakes.

[b] Significant effect in time,

[c] treatment,

[d] time x treatment interaction,

[e] gender,

[f] race,

[g] age, and

[h] weight from the mixed model analysis, $p<0.0015$.