"Everything is theoretically impossible, until it is done. One could write a history of science in reverse by assembling the solemn pronouncements of highest authority about what could not be done and could never happen."

—Robert Anson Heinlein

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Nutrition Close-Up is a quarterly publication of the American Egg Board, written and produced by the Egg Nutrition Center. *Nutrition Close-Up* presents up-to-date reviews, summaries and commentaries on the latest research on the role of diet in health promotion and disease prevention, including the contributions of eggs to a nutritious and healthful diet. Nutrition and healthcare professionals can request a free subscription to the newsletter by visiting the Egg Nutrition Center's website at www.enc-online.org.

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NUTRITION CLOSE-UP

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Results of the A TO Z Weight Loss Study

It's no news flash that obesity rates are on the rise. The overwhelming burden of obesity and associated comorbidities (diabetes, cardiovascular disease, arthritis, disability, loss of quality of life) on national healthcare and on individual quality of life has created an urgent need for interventions that work. The causes of the rapid rise of overweight and obesity in the US and beyond are points of disagreement among researchers, health professionals, policy makers, and academics; and proposed methods to curb this epidemic have been equally controversial. There are, perhaps, only two points on which all parties agree…1) the costs and health consequences associated with obesity and its comorbidities are overwhelming; and 2) the health benefits associated with almost any degree of weight loss are tremendous. Official dietary guidelines have undergone increased scrutiny as other, less conventional diet methods have grown in popularity. Some of these methods, such as the Zone, Atkins, and Ornish diets, appear effective in producing weight loss, but researchers and health professionals question their safety and long-term efficacy.

To address these questions, researchers from Stanford University compared one conventional diet (based on US dietary guidelines) and 3 popular diets head-to-head in a 12-month randomized trial (known as the "A TO Z Weight Loss Study") among 311 free-living premenopausal overweight or obese women (BMI 27-40). All participants were nondiabetic, otherwise healthy, and not taking any medication known to interfere with weight and/or energy expenditure. The women were randomly assigned to one of four diet treatment groups:

...diets low in carbohydrates can facilitate weight loss without producing the negative health consequences...[once] expected.

- Women in the Atkins (low-carbohydrate) group were instructed to reduce carbohydrate intake to <20 grams/day for the first 2-3 months ("induction" phase), and to maintain the carbohydrate level at <50 grams/day for the "ongoing weight loss" phase.
- Women assigned to the Zone diet group were instructed to maintain a macronutrient distribution of 40%-30%-30% (carbohydrate, protein, and fat).
- Those assigned to the Ornish diet group were expected to consume no more than 10% of calories from fat.
- The LEARN diet, based on national dietary guidelines, consisted of 55-60% of calories from carbohydrate and <10% of calories from saturated fat. This diet placed the most emphasis on behavior modification strategies. Women assigned to this diet group were assigned a calorie restricted diet regimen and were instructed to increase their physical activity level.

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The women assigned to one of the three popular diet groups followed exercise and dietary supplement prescriptions consistent with their respective diet plans.

Diet, physical activity, anthropometric, and metabolic data (including resting blood pressure along with plasma cholesterol, triacylglycerol, glucose, and insulin levels) were collected at baseline and again at 2, 6, and 12 months. 88%, 77%, 76%, and 78% of participants in the Atkins, Zone, LEARN, and Ornish groups, respectively, completed the 12-month study, with no significant difference between groups (P = 0.30). Although the mean energy intake for all groups (combined) decreased significantly at each time point, there was no difference in energy intake between groups at any time point (P>0.40). At all time points, statistically significant differences existed between groups with respect to carbohydrate intake, and patterns of nutrient intake differed between groups for fiber, protein, fat, and saturated fat. Carbohydrate and fiber intake was highest for those in the Ornish group, followed by the LEARN, Zone, and Atkins groups. Protein, fat, and saturated fat intakes were highest among Atkins group participants, followed by the Zone, LEARN, and Ornish groups. Mean energy expenditure increased modestly from baseline for all groups (P<0.05).

Retention rates for the Atkins, Zone, LEARN, and Ornish groups (88%, 77%, 76%, and 78%, respectively) did not differ significantly between groups (249 women completed the 12-month trial). Energy intake remained similar between groups throughout the study period. The Atkins diet group had lost significantly more weight by 2 and 6 months than any other diet group (P<0.05). The Atkins diet resulted in greater weight loss throughout the course of the study (-4.7 kg), but by 12 months, the magnitude of this weight loss was no longer significantly different from that of the Ornish (-2.6 kg) or LEARN diet groups (-2.2 kg). Only the Zone diet participants lost significantly less weight than the Atkins participants (-1.6 kg vs. -4.7 kg).

The Atkins diet regimen resulted in improvements in HDL cholesterol concentrations at 6 and 12 months (+5.1 and +4.9 mg/dL, respectively), but these levels were significantly different only from the Ornish diet (+4.9 mg/dL vs. no change, P=0.002) at 12 months. The Atkins diet also improved triacylglycerol concentrations at 2 and 12 months (-52.3 and -29.3 mg/dL), but the change was significantly different only from the Zone group at 12 months (-29.3 vs. -4.2 mg/dL, P=0.01). The Ornish and LEARN diet regimens resulted in more favorable changes in LDL cholesterol concentrations at 2 months (-10.1 and -7.3 mg/dL, respectively), but were no longer significantly different from the other groups after 6 and 12 months.

There were no significant changes in fasting insulin or fasting glucose concentrations over the course of the study for any of the diet groups. Mean blood pressure levels, however, did decrease, and favored the Atkins diet. Mean decreases in the Atkins diet group were -4.4 mm Hg at 12 months for diastolic blood pressure (significantly greater than the -0.7 mm Hg change in the Ornish diet group, P=0.009) and -7.6 mm Hg for systolic blood pressure (a significantly greater change than was observed for any other group, P<0.001).

After adjusting for the 12-month changes in weight, the differences observed between groups with regard to associated physiological changes (blood lipids and blood pressure) at 12 months remained significant, but the level of significance was attenuated. This indicates that some of these diet effects were, at least to an extent, independent of weight loss.

The A TO Z Weight Loss Study findings demonstrate that diets low in carbohydrates can facilitate weight loss without producing the negative health consequences that might have been expected from higher levels of fat intake. After a year, the Atkins high-protein, low-carbohydrate diet performed at least as well as the LEARN (based upon national guidelines) and Ornish diets with regard to weight loss, and performed significantly better than the Zone diet in this group of overweight/obese women. The Atkins diet resulted in a reduction in systolic blood pressure significantly greater than that produced by any other diet group and improved HDL cholesterol and triacylglycerol concentrations relative to the Ornish and Zone diets, respectively. Serum LDL cholesterol, glucose, and insulin levels were not significantly affected by any of the diets over the course of the year-long study. Additional research is necessary to clarify the reasons why the diet highest in protein and lowest in carbohydrate produced the most positive overall results. ■

Gardner CD, Kiazand A, Alhassan S, et al. Comparison of the Atkins, Zone, Ornish, and LEARN diets for change in weight and related risk factors among overweight premenopausal women. The A TO Z weight loss study: a randomized trial. *JAMA*. 2007;297:969-977.

KEY MESSAGES

- Although the women in the Atkins group had lost the most weight at 2 and 6 months, by 12 months, the difference in average weight loss between groups had all but disappeared. Only the Zone diet participants had lost significantly less weight than the Atkins participants at 12 months.
- In this population, the Atkins diet was shown to be more effective than the Zone, Ornish or LEARN diets in reducing systolic blood pressure.
- The Atkins diet also improved HDL cholesterol and triacylglycerol concentrations relative to the Ornish and Zone diets, respectively.

Special Feature:

Egg Nutrition Research Presented at Experimental Biology 2007

Egg breakfast enhances weight loss

Background: A preliminary study demonstrated the satiety potential of eggs.

Objective: The objective of this follow-up study was to examine the effects of an egg breakfast on weight loss in overweight and obese participants.

Methods: A total of 160 overweight and obese, but otherwise healthy, participants were randomized to one of four treatment groups (Egg, Egg-Diet, Bagel, or Bagel-Diet). Those assigned to the two egg groups consumed a breakfast containing 2 eggs (providing 340 kcals) at least 5 days/week for a total of 8 weeks. Those assigned to the bagel groups consumed a bagel breakfast (equal to the egg breakfast in weight and kcal contribution) for a total of 8 weeks. Those in the two "diet" groups ate their respective assigned breakfasts, but consumed low-fat, calorie-restricted diets (1000 kcal deficit).

Results: Participants in both of the diet (low-fat, kcal restricted) groups experienced some weight loss, but participants in the egg breakfast diet group lost 65% more weight, on average, than those in the bagel diet group (-6.0 ± 5.0 vs. -3.5 ± 5.2 lbs, $p<0.05$). The egg breakfast diet group also experienced an 83% greater reduction in waist circumference than the bagel breakfast diet group ($p<0.05$). Participants in the egg diet group also reported feeling more energetic over the course of the study when compared with the energy level rankings of the bagel diet group ($p<0.05$).

Conclusion: These findings suggest that eating eggs (vs. bagels) for breakfast enhances weight loss for those on calorie restricted diets.

Dhurandhar NV, Vander Wal JS, Currier N, et al. Pennington Biomedical Research Center, Louisiana State University, St. Louis University, and Wayne State University. Research supported by a grant from the American Egg Board

Macular pigment density improves with egg consumption during statin therapy

Background: Lutein and zeaxanthin are protective plant pigments that are deposited in the macula and help prevent age-related macular degeneration. Studies have demonstrated that increased intake of lutein and zeaxanthin from egg yolk boosts levels of these carotenoids in the serum and macula and that the increase correlates to the degree of serum response to the added dietary cholesterol.

Objective: Determine the effects of high lutein and zeaxanthin intake from egg yolks in elderly individuals on statin therapy.

Methods: In this study, adults aged 60 and older who had been undergoing statin therapy for at least 3 months were recruited to complete this 18-week study consisting of 4 phases. During phases 1 and 3 (washout phases), participants were to refrain from consuming eggs for a period of 4 weeks. During phases 2 and 4 (5 weeks each), participants consumed the equivalent of 2 and 4 egg yolks per day. Serum lutein and zeaxanthin levels and macular pigment optical density (MPOD) were measured at the end of each study phase.

Results: Serum lutein levels increased by 25% in phases 2 and 4 ($P<0.001$) compared to washout levels ($P<0.001$). Serum zeaxanthin levels increased by 26.7% ($P=0.019$) and 63.7% ($P<0.001$) following phases 2 and 4, respectively. MPOD increased by 26.5% following phase 2 and by 30% ($P=0.039$) following phase 4.

Conclusion: These findings indicate that egg yolk feeding does increase lutein and zeaxanthin concentrations, both in the serum and in the macula, even in individuals on statin therapy.

Mutung G, Ratliff J, Waters D, Torres-Gonzalez M, Clark RM, Volek JS, Fernandez ML. University of Connecticut, Storrs. Research supported by a grant from the American Egg Board.

Serum lipid levels improve with intake of four eggs per day in older adults on statin therapy

Objective: Determine the effects of high dietary cholesterol intake in elderly individuals on statin therapy.

Methods: (Study is not yet complete.) Adults aged 60 and older who have been undergoing statin therapy for at least 3 months are being recruited for an egg-feeding study that will address macular degeneration. So far, 65 of these individuals have completed all four phases of this 18-week study. During phases 1 and 3 (4 weeks each), participants were to refrain from consuming eggs. During phases 2 and 4 (5 weeks each), participants consumed the equivalent of 2 and 4 egg yolks per day. Serum lipid and lipoprotein levels were measured twice for each phase.

Results: Serum lipids did not rise in response to the increased dietary cholesterol load of up to 1000 mg/day. LDL cholesterol concentrations decreased by 10% ($P<0.003$) and HDL cholesterol increased 7% ($P<0.002$) in participants consuming 4 eggs per day.

Conclusion: Statins appear to control serum cholesterol levels even when dietary cholesterol intake is high.

Nicolosi RJ, Goodrow E, Wilson T. Center for Health and Disease Research, University of Massachusetts, Lowell. Research supported by a grant from the American Egg Board

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1979

Questioning the Status Quo:

"Indiscriminate exclusion of eggs may be a useless preventive measure to maintain low serum cholesterol in...normal healthy men"

In 1970, the American Heart Association (AHA) introduced its recommendation that healthy Americans consume no more than 300 mg dietary cholesterol per day to prevent atherosclerotic disease. However, Keys et al., by 1956, had already reported minimal changes in serum cholesterol at various levels of egg intake. In 1977, the Senate Select Committee on Nutrition and Human Needs issued its "Dietary Goals for the United States," which echoed the AHA recommendation. That same year, Flynn et al. published new research showing that in healthy, normocholesterolemic, free-living men, the consumption of one large egg per day (representing the addition of 250 mg dietary cholesterol) over the course of 3 months did not appreciably change serum total cholesterol levels.

In an effort to find out if additional dietary cholesterol would result in the expected increase in serum cholesterol levels, the same group of researchers undertook a similarly-designed cross-over study in which healthy, free-living men would consume 2 eggs/day (representing an additional 500 mg dietary cholesterol per day) for a period of 3 months. Healthy, normocholesterolemic men between the ages of 32 and 62 years were recruited from the faculty and staff of the University of Missouri-Columbia (90% of whom had also participated in the original egg-feeding trial).

Participants were assigned to the egg group or the egg-avoidance group for a period of 12 weeks, after which they switched to the alternate dietary regimen. The men were asked to restrict certain egg-containing baked goods and to completely eliminate foods such as custards, French toast, etc…for the duration of the study (6 months). During the egg feeding period, the men were asked to consume two whole eggs daily in addition to their customary intake. During the egg-avoidance period, they were asked to eliminate whole eggs from their diets. Participants were also advised to maintain their normal activity levels to ensure that their weight did not fluctuate over the course of the study. One 4-day food intake record was completed during each diet treatment period to monitor compliance. Fasting blood samples were taken at baseline and following each treatment phase to measure total serum cholesterol and triacylglycerol concentrations.

Compliance was good and the men successfully stayed within 1 kg of their baseline body weights. During the egg-feeding phase, absolute intake of protein and fat were higher than during the egg-avoidance phase, but macronutrient distributions were similar between diet treatment periods. During the egg-avoidance phase, 17% of total calories came from protein, 38% from fat, and 45% from carbohydrate. During the egg-feeding phase, 17% of total calories were derived from protein, 39% from fat, and 43% from carbohydrate.

No significant increase in mean serum cholesterol was observed in this cohort after egg feeding (Table 1). Individual responses to the changes in egg intake varied widely. Of the group that underwent the egg-feeding regimen first (group 1), 82% experienced a decrease in serum cholesterol concentration after the egg-avoidance phase, compared to 55% in group 2. Interestingly, 55% of group 2 participants experienced a decrease in serum cholesterol concentrations following both study phases.

These observations mirror those of the preliminary study completed 2 years earlier that used one whole egg instead of two for the egg-feeding treatment (Porter et al., 1977). They also support the findings of Keys et al. (Keys et al., 1956) that serum cholesterol concentrations did not change significantly following long-term, sustained changes in dietary cholesterol consumption. They concluded that their observations "further support the suggestion that indiscriminate exclusion of eggs may be a useless preventive measure to maintain low serum cholesterol in…normal healthy men." ■

Flynn, MA, Nolph GB, Flynn TC, et al. Effect of dietary egg on human serum cholesterol and triacylglycerol (TAG). *Am J Clin Nutr* 1979;32:1051-7.

Porter MW, Yamanaka W, Carlson S, and Flynn MA. Effect of dietary egg on serum cholesterol and triglyceride of human males. *Am J Clin Nutr* 1977;30:490.

Atherosclerosis Study Group. Primary prevention of the atherosclerotic diseases. *Circulation* 1970;42:supplement 1.

Dietary Goals for the United States. Washington, D.C.: Superintendent of Documents, 1977.

Keys A, Anderson JT, Mickelsen O, et al. Diet and serum cholesterol in man: lack of effect of dietary cholesterol. *J Nutr* 1956;59:39.

Table 1: Changes in Serum Lipids by Diet Assignment

Group Assignment	Diet	Serum Lipids (mg/dL)	
		total cholesterol	triacylglycerol
Group I			
baseline		214 ± 35 (5)	115 ± 58 (9)
diet phase 1	EGG	213 ± 30 (4)	108 ± 65 (6)
diet phase 2	No EGG	194 ± 31 (4)	102 ± 48 (6)
Group II			
baseline		203 ± 39 (6)	117 ± 59 (8)
diet phase 1	No EGG	198 ± 36 (4)	103 ± 39 (5)
diet phase 2	EGG	198 ± 40 (5)	100 ± 54 (7)

Folate intake and ethnicity influence choline status in young women

Background: Adequate maternal choline and folate stores are vital for a healthy pregnancy. Choline is essential for proper fetal neurodevelopment and is thought to play an important role in the early development of memory and cognition. Like folate, choline has been shown to prevent neural tube defects. Because pregnancy places high demands on maternal choline stores, adequate intake during pregnancy is critical.

Research indicates that folate and choline are interrelated and that ethnicity helps determine folate status. African American women have been shown to have lower folate nutriture than Caucasian and Mexican American women at similar intake levels. The impact of ethnicity on choline nutriture is not known.

Objective: Determine the influence of ethnicity on choline status under conditions of controlled folate intake.

Methods: A total of 42 women (14 Mexican American, 14 African American, and 14 Caucasian) took part in this 14-week study. During the first 7 weeks, they consumed a folate-restricted diet providing only 135 mcg DFE/day. For the next 7 weeks, the women consumed either 400 or 800 mcg DFE/day. Total choline intake was to remain constant throughout the study at ~350 mg/day.

Results: Plasma betaine concentrations were influenced by ethnicity and level of folate intake ($P=0.0392$) and showed a tendency to decrease during folate restriction for all participants ($P=0.0783$). Plasma betaine concentrations also tended to increase less in African American women undergoing the 800 mcg folate treatment vs. the other ethnic groups (0.052). Phosphatidylcholine levels decreased during the folate restricted period ($P<0.001$). These levels tended in increase during the folate treatment period in Mexican American and Caucasian women, but showed a tendency to decline in African American women during folate treatment ($P=0.056$).

Conclusion: This study suggests that ethnicity plays a role in choline nutriture, especially in the response to varying folate intake levels. These observations also indicate that the disparity in folate status between African American women and their Caucasian and Mexican American counterparts is also associated with lower choline status.

Abratte C, Hung J Wang W, et al. California State Polytechnic University, Pomona, CA. Research supported by and NIH grant and funds from the California Agricultural Research Initiative

Including eggs in a reduced-carbohydrate diet increases serum HDL and lutein levels

Background: Carbohydrate restricted diets have been demonstrated to decrease body weight and improve the plasma lipid profile (decreasing triacylglycerol (TAG) levels and increasing HDL cholesterol concentrations) in individuals undergoing weight loss. Lutein is a dietary carotenoid that helps protect against cataracts and age-related macular degeneration. Egg yolks are one source of dietary lutein and have been shown to increase both lutein and HDL cholesterol levels.

Objective: Determine the effects of including whole eggs in a carbohydrate-restricted diet for weight loss in overweight and obese men.

Methods: In this study, overweight and obese men (BMI = 25-37 kg/m^2) aged 40-70 years participating in a weight loss intervention were assigned to one of two carbohydrate-restricted diet treatment groups for a period of 12 weeks. The first group was assigned to consume 3 whole eggs (providing an additional 640 mg cholesterol and 600 mcg lutein) per day. The second group was assigned to consume an equivalent amount of egg whites only (providing no additional cholesterol or lutein) daily.

Results: All participants experienced significant reductions in body weight, BMI, and waist circumference from baseline following the dietary treatments. TAG concentrations also dropped significantly for all study participants (from 107.4 ± 48.7 to 77.0 ± 30.9 mg/dL; $P<0.05$). LDL cholesterol levels did not change as a result of the interventions. Whole-egg group participants experienced significant increases in HDL cholesterol levels (56.0±16.6 to 66.4 ± 15.7 mg/dL, $P<0.05$), while the group consuming only egg whites did not see any increases in HDL cholesterol. Lutein also increased for those in the whole-egg group from 0.6450 mmol/L to 1.17 mmol/L, but did not change for those in the egg-white-only group.

Conclusion: These results suggest that including whole eggs in a carbohydrate-restricted diet improves HDL and TAG levels and increases plasma lutein.

Mutung G, Ratliff J, Waters D, Torres-Gonzalez M, Clark RM, Volek JS, Fernandez ML. University of Connecticut, Storrs. Research supported by a grant from the American Egg Board.

Consumption of one egg per day increases serum lutein and zeaxanthin concentrations without altering serum cholesterol levels

Background: Lutein and zeaxanthin are protective plant pigments that are deposited in the macula and are associated with decreased incidence of age-related macular degeneration.

Objective: Evaluate the effects of consuming 1 egg per day for a period of 5 weeks on serum concentrations of lutein, zeaxanthin, lipids, and lipoprotein cholesterol in older adults (>60 years of age).

Methods: In this study, 33 adults aged 60 and older were recruited to complete this 18-week cross-over study consisting of 4 phases. During phases 1 and 3 (washout phases), participants were to refrain from consuming eggs for a period of 4 weeks. During phases 2 and 4 (5 weeks each), participants consumed 1 egg per day or an equivalent amount of egg substitute.

Results: Serum lutein and zeaxanthin concentrations increased significantly following the egg treatment period (26 and 38%, respectively) in comparison to the preceding washout phase. Serum HDL, LDL, and triacylglycerol concentrations did not change following the egg intervention.

Conclusion: These results suggest that older adults can achieve significant increases in serum lutein and zeaxanthin levels with egg intake (1 egg/day) without negatively affecting serum lipid concentrations.

Wilson TA, Goodrow E, Houde S, Vishwanathan R, Scollin P, Handelman G, Nicolosi RJ. University of Massachusetts Lowell, Lowell, MA. Research supported by a grant from the American Egg Board and The Massachusetts Lions Eye Research fund, Inc.

EDITORIAL

An A to Z Sacrilege of Dietary Belief

For over thirty years I've heard how the low-carb, high-protein Atkins diet was a public health menace, a fraud on an unsuspecting public…and just plain deadly. It was berated as a high-fat, cancer-promoting, bone-weakening, atherogenic fad diet. And the name-calling didn't stop there. Its promoter was accused by many to be an unscrupulous quack out to make a fast buck. Of course the most vicious attacks were based on the lack of sound scientific evidence that the diet might actually work and that it might not cause the dietary disasters we had come to expect. And so the super-low-fat diet versus the super-low-carb diet became the great debate and the belief lines were drawn. (I say belief lines because, contrary to popular opinion, there wasn't much direct science to support either.) Of course, any scientific study supported by the Atkins Foundation was automatically labeled as biased and the findings negated. (It's a bit of a challenge when they ask you to prove your hypothesis when you aren't allowed to fund any studies…and the "powers that be" make sure that any grant requests to do so are summarily rejected.)

Then, all of a sudden, the public goes crazy for low-carb diets (maybe out of frustration with the recommended low-fat diet?) and word of mouth from satisfied consumers outpaces an outdated, slow-evolving pyramid. The only course of action left to the low-carb, high-protein critics is to scientifically prove that the Atkins diet is nutritional folly and show consumers the error of their ways…and to make sure the study compares the extremes with the prudent to finally quiet those who doubt the wisdom of the founding fathers of the Step I diet. Well, the results are in, and the winner is (drum role please) …

No! Impossible! It cannot be! Who funded this study? What industry ties do the investigators have? What kind of conclusion is

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Editorial *continued from page 7*

THIS? "In this study, premenopausal overweight and obese women assigned to follow the Atkins diet, which had the lowest carbohydrate intake, lost more weight and experienced more favorable overall metabolic effects at 12 months than women assigned to follow the Zone, Ornish or LEARN diets."? Nutritional blasphemy! Call out the attack dogs and save our low-fat diet!

Okay, I'll admit it. There is a certain joy in seeing science confirm the beneficial effects of something that everybody just knew (or thought they knew) was detrimental. (Of course this has also happened to the egg, which is why I take delight in seeing it happen to other dietary outcasts.) Sometimes you actually have to do the studies before you decide that "this is good" and "that is bad." Nutrition is on its head with so many positive nutrients not getting past the null hypothesis and many "negative" foods and dietary patterns finally being allowed to remove their "this will kill you" labels. Confusing for the public, but certainly exciting for nutrition scientists. My mentor, E.H. "Pete" Ahrens, Jr., MD, noted in 1978 that implementation of the recommended dietary guidelines would be a giant experiment on a population level which would be almost impossible to reverse. So after thirty years with rampant obesity and an impeding diabetes tsunami, how do we measure our "return on investment" for promoting the untested and unproven low-fat, high-carb diet as the one and only salvation for every man, woman and child in the country? Was it a gain or a loss? ■

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NUTRITION CLOSE-UP

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