



# Health Connections

LINKING NUTRITION RESEARCH TO PRACTICE

## BEYOND CALORIES:

# Macronutrient Composition of the Diet

Variations of low-carbohydrate, high-protein diets have been around for decades if not centuries. Current consumer interest in diets like the Atkins or South Beach Diets – and speculation as to their ability to produce results – has generated research to test their efficacy and answer key questions:

- Do changes in the macronutrient composition of the diet result in additional weight loss beyond what can be attributed to a lower caloric intake alone?
- Are there factors other than the energy derived from macronutrients involved in fat metabolism and storage?
- Do small metabolic changes in energy expenditure at the molecular level confer physiological benefits in weight management?

The prevalence of obesity among U.S. adults age 20-74 years is now 31 percent; 64 percent are overweight or obese.<sup>1</sup> Because the average American adult only gains one to two pounds a year, a small daily decrease in the caloric intake, or increase in metabolic expenditure through activity, could yield enormous public health benefits.

### IS A CALORIE A CALORIE? – PART OF THE WEIGHT DEBATE

A symposium at the recent Experimental Biology conference entitled “The Weight Debate: Balancing Food Composition and Physical Activity”<sup>2</sup> asked an intriguing question: Is a calorie a calorie? Apparently some consumers think not. Fifty-two percent of Americans believe they can lose weight and keep it off by reducing carbohydrates alone without counting calories.<sup>3</sup> This rejection of calorie counting is reminiscent of the 1990s, when low-fat and reduced-fat products flooded the marketplace yet did not result in curtailing what many call the obesity epidemic. From a purely

thermodynamic perspective a calorie is a calorie, however **research is beginning to reveal why one diet may result in greater weight loss over another.**

Bucholz and Schoeller<sup>4</sup> reviewed studies that compared weight loss and energy expenditure in adults eating diets high in protein and/or low in carbohydrate with those eating diets high in carbohydrate and/or low in fat. Diets high in protein and/or low in carbohydrate resulted in approximately a 2.5 kg greater weight loss after three months of treatment. The energy intakes of the treatment groups in most studies were similar, raising the questions of the effect of macronutrient composition of the diet on weight loss and possible reasons for the difference. Some reasons, explored by Bucholz and Schoeller, include a macronutrient’s 1) difference between gross and metabolizable energy, 2) ability to alter energy expenditure through change in resting metabolic rate or through the Thermic Effect of Food (TEF), 3) influence on satiety, or 4) ability to alter the composition of weight loss.

### METABOLIZABLE ENERGY

In the human body, thermodynamics may not reflect “pure” physics. The “gross” energy of macronutrients, as determined by bomb calorimetry, does not take into account losses through digestion and

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excretion. Metabolizable energy — the difference between the gross energy of the food and the energy contained in feces and urine — is estimated to be 4, 4, and 9 calories per gram of carbohydrate, protein and fat respectively. Because these “Atwater factors” were derived from average values of mixed diets, using them to estimate metabolizable energy from reported food intake, or to design weight loss studies, is not exact.

**REFERENCES**

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<sup>2</sup> ASNS/ASCN Public Information Committee symposium. Experimental Biology 2004, Washington, DC. Am J Clin Nutr 79, (supp) 896S-930S.

<sup>3</sup> Roper ASW survey for Slim-Fast Foods, Co. 2004. May 2, PRNewswire.

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<sup>5</sup> Institute of Medicine 2002. Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids. Washington DC: National Academy Press.

<sup>6</sup> Gerstein DE, et al. J Am Diet Assoc. 2004; 104:1151-1153.

<sup>7</sup> Zemel MB. Am J Clin Nutr 2004(suppl):907-12S.

<sup>8</sup> Heaney RP, et al. J Am Coll Nutr 2002. Apr;21(2):152S-155S.

<sup>9</sup> Hill JO, et al. Science. Feb. 7, 2003. Vol. 299:853-55.

**DIET-INDUCED CHANGES IN ENERGY EXPENDITURE**

Previously referred to as the Specific Dynamic Action (SDA) of food, the increase in metabolism with food intake now is referred to commonly as the Thermic Effect of Food (TEF). TEF reflects the metabolic costs of handling and storing ingested nutrients. The increase in energy above baseline during digestion varies from 5 to 10 percent for carbohydrate, 0-5 percent for fat, and 20-30 percent for protein. The TEF of mixed diets is thought to be approximately 10 percent.<sup>5</sup>

Buchholz and Schoeller<sup>4</sup> cite research on the effect of changes in percentage of energy from protein on total energy expenditure. Based on a meta-analysis, TEF increases about 7 kcal per 1000 kcal of food for each 10 percentage points in the energy derived from protein. On a 1500-kcal/d diet with 35% energy from protein, the predicted TEF would be 21 kcal/d higher than a diet in which the protein contributed 15% of the energy. Thus there is some evidence that increasing protein to 30-35 percent of energy — the high end of the Institute of Medicine’s suggested Acceptable Macronutrient Distribution Range (AMDR), (see table) — could slightly increase total daily energy expenditure.

**SATIATION AND SATIETY**

Continuing and emerging research indicates that macronutrients influence food intake — taste, mouth feel, chewing time, stomach distention,

digestibility, rate of absorption, hormonal changes, and metabolic signals. Since macronutrients affect satiation (controlling food intake/meal size or intrameal regulation) and satiety (subsequent hunger and eating or intermeal regulation<sup>6</sup>) they can affect total calorie intake — and thus weight. Diets high in protein and/or low in energy density increase satiety. High fat, high energy-dense diets have been proposed to have a weak effect on both satiation and satiety, which might lead to over-consumption of calories.

**ENERGY PARTITIONING AND THE COMPOSITION OF WEIGHT LOSS: CALCIUM AS A CASE STUDY**

New research suggests that factors other than macronutrient-derived energy are involved in the metabolism and storage of fat.<sup>7</sup> Over the past few years the anti-obesity effect of dietary calcium has been shown in animal studies, epidemiological studies and clinical trials.<sup>8</sup> This effect occurred on diets with a constant protein intake, indicating that the protein content *per se* was not responsible — although specific amino acids may be.

Heaney et al.<sup>8</sup> maintain that each 300 mg increase in calcium intake is associated with 1 kg less body fat in children and 2.5-3 kg less body weight in adults. Clinical trials on the effects of calcium and dairy products on adiposity have shown that in addition to weight and fat loss, there was a change in distribution of the fat loss with more fat lost from the trunk region. The inclusion of three daily servings of dairy products in the diets of obese African American adults maintained on eucaloric diets for six months resulted in a 5.4 percent reduction in total body fat and a 4.6 percent reduction in trunk fat. The control group consumed a low calcium, low-dairy diet with the same macronutrient composition but showed no significant changes in either total body or trunk fat. In the absence of energy restriction, the inclusion of dairy products appears to result in the repartitioning of dietary energy away from adipose tissue to lean body mass, resulting in an overall reduction in fat mass.<sup>7</sup>

The anti-obesity effect of dairy foods is explained only partly by calcium in that calcium supplementation alone does not exert an anti-obesity effect of the same magnitude. Other bioactive compounds in dairy products that may be involved include the whey-fraction branched-chain amino acids (BCAA) and leucine specifically.<sup>7</sup>

ACCEPTABLE MACRONUTRIENT DISTRIBUTION RANGES	
MACRONUTRIENT	PERCENT OF ENERGY
Protein.....	10-35%
Fat.....	20-35%
Carbohydrate.....	45-65%

*Source: IOM 2002*

*Dr. Heymsfield, MD, Director, St. Luke's-Roosevelt Medical Center Obesity Research Center's Weight Control Units and Body Composition Laboratory, and moderator of The Weight Debate, offered these additional comments on macronutrient composition of the diet and weight management. Dr. Heymsfield's research focuses on thermogenesis and body composition in aging and chronic illnesses.*

**Q: On the food intake part of the energy balance equation, is a calorie a calorie?**

A: While the number of calories may be the same, for instance 100 calories from protein or 100 calories from carbohydrate, some forms of energy are more satiating than others. The perception of fullness that comes from consuming protein could result in eating less overall. On the other hand, high-fat foods are generally not as satiating and often lead to overconsumption of calories. Thus, on the energy intake part of the equation, although a calorie is a calorie, macronutrients can influence energy intake simply through their satiation potential. This is important to remember when developing weight control diets for individuals.

**Q: Are there other nutrients or factors that possibly affect body composition or weight management?**

A: The obesity epidemic has resulted in revisiting results of some of the past research that has been out there for the asking, such as the role of different sugars and long chain carbohydrates on hunger, satiety and long-term food intake. The role of rapidly absorbed sugars such as sucrose and fructose on insulin response and satiety is an area of research to watch. As another example, calcium is not a traditional macronutrient in that there is no energy in calcium per se, yet somehow it mediates energy metabolism, as Zemel has described.<sup>7</sup> High calcium intake can also inhibit synthesis of fat and increase oxidation, perhaps resulting in weight change.

**Q: Can a calorie here or there expended at the molecular level help consumers slow or prevent weight gain over time?**

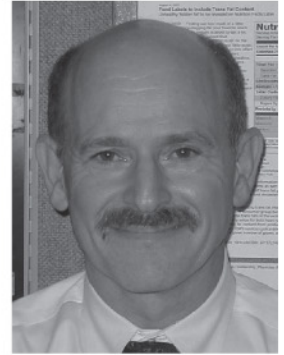
A: Most likely yes....even small differences in intake or output, not compensated for over long time periods, can translate into changes in weight. The key is to not over-compensate for these changes. For example, often with an increase in physical activity, people also increase intake. The end result is their weight remains stable... and they can't figure out why they're not losing weight.

**Q: Wouldn't it be advantageous given our obesity epidemic, if calories could be directed to thermogenesis (wasted heat) rather than into fat storage?**

A: Yes. But how to do that safely has not yet been established other than by exercising. There are some obesity drugs that have this effect but they may carry some significant risks.

**Q: What message would you give to health professionals who are working with overweight and obese clients?**

A: Encourage clients to eat a healthy diet, with macronutrient distribution of calories as recommended by the Institute of Medicine (see table), and to exercise, avoid fad diets and consume dairy products for good health and calcium. There are no miracles over the long term.



Dr. Heymsfield, MD

## PRACTICE POINTS FOR THE HEALTH PROFESSIONAL

- Give consumers a quantitative goal for change in energy balance — a change of 100 kcal a day is sufficient to stop weight gain in 90 percent of the population.<sup>9</sup> Through portion control, most consumers could easily eat 100 kcal/day less without changing the types or patterns of foods they eat.
- Encourage personal responsibility. Help clients take control of their body weight by determining how often and how much to eat, and how much to exercise, to lose or maintain their weight over time.
- Encourage regular lifestyle focused physical activity — emphasize functional benefits of staying fit such as having the ability and energy to lift wheelies into airline overhead racks or to keep up with the children and grandchildren.
- Encourage nutrient-dense foods from all food groups to ensure adequate micronutrient intake within caloric requirements.
- Stay informed. To help clarify the complexities of weight management for your clients, stay abreast of research on:
  - ❑ hormones produced in the stomach or digestive track that play a role in short-term weight regulation and signaling how often/how much to eat.
  - ❑ the role of other dietary components including alcohol in fat metabolism.
  - ❑ dietary components that may alter energy partitioning by channeling energy into heat rather than fat.