

DIETARY APPROACHES TO MANAGE Body WEIGHT

Brought to you by the team of Registered Dietitians at Kellogg Canada Inc.



Simone Lemieux, Ph.D., RD

Dr. Simone Lemieux has a master's degree in nutrition and exercise science and completed a PhD in physiology from Laval University in 1996. She did a post-doctoral fellowship in the department of medicine of the University of Toronto and is now assistant professor in the department of food science and nutrition at Laval University and an Obesity Chair researcher.

Dr. Lemieux's research interests include the prevention and treatment of obesity, type 2 diabetes and their complications in women. She is also interested in developing nutritional strategies that prioritize functional foods and nutraceuticals to prevent and treat obesity- and diabetes type 2-linked pathologies.



Annie Lapointe MSc., RD

Annie Lapointe is currently a Ph.D. student at the Institute of Nutraceuticals and Functional Foods, Laval University, under the supervision of Dr. Simone Lemieux. The focus of her PhD project is on the effect of a weight loss intervention focusing on the increase in fruit and vegetable intakes in overweight-obese postmenopausal women.



It has been established in the Canadian Community Health Survey that 23% of Canadians are obese while 36% are overweight.¹ The fact that obesity is associated with an increased risk of developing cardiovascular disease, type 2 diabetes and other chronic diseases explains why many efforts have been put forward to develop tools that can be helpful for achieving body weight loss.

Nutritional intervention is at the cornerstone of obesity treatment. In order to achieve body weight loss, energy intake must be lower than energy expenditure. This mathematical equation is rather simple and can falsely

suggest that achieving long-term body weight loss is simple and easy. However, many studies have demonstrated the poor long-term success of weight loss interventions.^{2,3} Biological as well as behavioural and environmental factors can all contribute to body weight regain after weight loss.

This paper will discuss some nutritional strategies that can be helpful to induce a reduction in energy intake. Namely, the impact of reducing energy density, reducing portion size and improving the recognition of hunger and satiety signals and diet modification will be discussed.

Impact of energy density of the diet on spontaneous energy intake

In cross-sectional studies, Barbara Rolls showed that when subjects were offered either a high-energy density or a low-energy density meal in ad libitum conditions, those eating the high-energy density meal systematically had a higher energy intake. The difference in spontaneous energy intake between high versus low-energy density meals can be considerable. For example, a study by Bell and Rolls⁴ showed that when obese women were offered low-energy density meals (1.2 kcal/g) for one day they ate less energy (1724 kcal vs 2145 kcal) than when they were offered meals with high-energy density (1.6 kcal/g).

Interestingly, in many studies it was shown that despite a lower energy intake, subjects eating low-energy density meals were as satiated as subjects on

high-density meals.^{4,5} This suggests that lowering the energy density of the diet can be a useful tool in weight loss interventions. Accordingly, a study by Eilo-Martin and colleagues⁶ showed that a nutritional intervention focusing on reducing dietary fat was more effective to reduce body weight when accompanied by an increase in the consumption of fruit and vegetables.

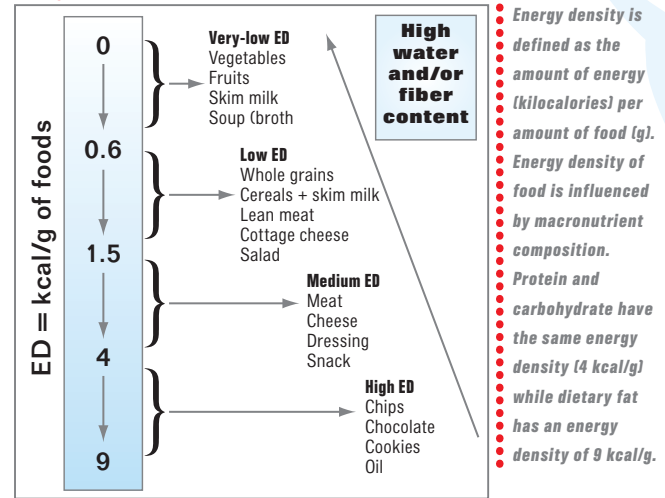
In fact, women who were advised to decrease dietary fat and to increase fruit and vegetable consumption lost an average of 7.9 kg after one year of intervention compared to a loss of 6.4 kg in women advised only to reduce dietary fat.⁶ One explanation by the authors for these results is that women who reduced dietary fat and increased their consumption of fruit and vegetables had an overall diet with a lower energy density. These results all together suggest that reducing energy density can be a good target in weight loss intervention.



The link between low-energy density and weight loss can be explained by the fact that people appear to consume a constant weight of food each day, as opposed to a constant amount of energy. Therefore, selecting low-energy density foods provides fewer calories per eating occasion. Moreover, some components of low-energy density foods such as fibre and proteins can enhance satiety. Accordingly, it has been suggested that for a given energy content, protein has a higher satiating effect than carbohydrate and lipids.⁷

The satiating effect of protein is not fully understood but some mechanisms have been proposed. In 1965, Mellinkoff et al.⁸ suggested that there is a satiety center in the brain that is sensitive to serum amino acid levels and once a certain level is reached, hunger ceases. It has also been suggested that increased protein intake increases thermogenesis that is associated with increased oxygen consumption and body temperature that would in turn increase satiety.⁹ Finally, it has also been proposed that the ingestion of dietary protein could be associated with blood elevation of gut hormones such as cholecystokinin that favour a reduction in appetite and energy intake.¹⁰

Figure 1: Energy density (ED) of common foods



Impact of portion size on spontaneous energy intake

Different experiments have been conducted to evaluate the impact of portion size on energy intake. Studies conducted in laboratory settings with different types of foods have concluded that when subjects are served larger portions they eat more without feeling increased fullness. For example, in a study performed by Rolls and colleagues men and women were served different portions of macaroni and cheese.¹¹ It was found that they consumed 30% more energy when offered the largest portion (1000g) than when offered the smallest portion (500g).

...intervention should focus on education about adequate portion size and also on the recognition of hunger and satiety signals.

In more naturalistic settings (i.e. cafeteria-style restaurant), it was found that when the size of pasta entrée was increased by 50% (from 248g to 377g), energy intake was increased by 43%.¹² It could be argued that overall, portion size has little impact on body weight since after eating more from a larger portion size people could compensate at subsequent

meals by eating less. However, studies report that the consumption of larger portion sizes can persist over several days without appropriate compensation at subsequent meals.^{13,14}

The mechanisms by which increased portion sizes are leading to increased energy intake are not perfectly understood. One potential explanation is that most people do not have a precise perception of what an appropriate portion size is for them. In fact, a survey conducted by the American Institute for Cancer Research found that 54% of Americans decided the amount of food they would eat at a single meal on the basis of the amount they were served.¹⁵

It has been suggested that the fact that both the portion sizes provided in restaurants and that the proportion of meals taken in restaurants has increased over the years is probably contributing to the increased obesity prevalence.¹⁶ These results suggest that many people rely on external factors rather than on internal ones (hunger and satiety signals) to determine their food intake and that intervention should focus on education about adequate portion size and also on the recognition of hunger and satiety signals.



Recognition of hunger and satiety signals

Studies have suggested that the ability to recognize hunger and satiety signals could be influenced by numerous factors such as the practice of physical activity, gender and genetics. In fact, it was shown that habitual exercisers demonstrated a better accuracy in regulation of food intake in compensation of previous energy intake than subjects who do not exercise regularly.¹⁷

In non exercisers, ad libitum energy intake following either a high energy or a low energy milkshake (601 kcal vs 241 kcal) was not different whereas in exercisers, following the high energy milk shake intake was significantly lower than following the low energy milkshake.¹⁷ A recent study by Davy et al.¹⁸ showed that men had more accurate energy regulation than women in acute conditions during which they received either a preload (yogurt) or no preload 30 min prior to an ad libitum meal.

Despite the fact that many factors appear to influence the recognition of hunger and satiety signals, few intervention studies have demonstrated that it is

possible to improve the accuracy of internal signals that regulate food intake. Provencher, et al.¹⁹ conducted an intervention aimed at improving hunger and satiety signals in premenopausal overweight-obese women. A weight management approach named "Choisir de Maigrir?" (What about losing weight?), which focuses on general well-being, as well as positive ways of having a healthy and satisfying lifestyle, was used.

During this intervention, a weekly food diary and group discussions were used to facilitate the recognition of internal cues of hunger and satiety (rated on a 3-point scale) and the identification of external influences on eating behaviors. After 16 weeks of intervention, it was found that women from the intervention group had a significant decrease in post-meal ratings for desire to eat and hunger.¹⁹ From these results, it may be argued that women participating to "Choisir de maigrir?" developed a better ability to be conscious of their physical signals of hunger and satiety.



Modification of diet quality to improve metabolic profile of obese individuals

Although body weight loss has been proved to have numerous beneficial effects on the metabolic profile of obese individuals²⁰, long-term success of interventions is still disappointing with most subjects regaining the weight lost. Considering the difficulties associated with body weight loss and maintenance, it might be suggested that nutritional strategies aiming at modifying diet quality without inducing energy deficit might be an alternate approach to improve metabolic profile of obese individuals.

Studies have suggested that independent of weight loss, some dietary modifications can improve metabolic profile of obese individuals. For example, consumption of whole grains has been associated with better insulin sensitivity²¹ while high intakes of fruit and vegetables have been linked to a reduced risk of stroke²² independent of body weight. The quality of dietary fat has also been linked to many metabolic parameters and it has been suggested that a diet low in saturated and trans fat and containing adequate amounts of polyunsaturated omega-3 fatty acids mainly from fish is desirable for the prevention of cardiovascular diseases.²³

Researchers have also been interested in examining dietary patterns rather than food components taken separately to study the association between diet and health. Accordingly, the traditional Mediterranean diet has been the topic of many epidemiological and clinical studies. The traditional Mediterranean diet is characterized by an abundance of fruit, vegetables, whole grain cereals, nuts and legumes; olive oil as the main source of fat; fish and poultry consumed in

Studies have suggested that independent of weight loss, some dietary modifications can improve metabolic profile of obese individuals

moderate amounts; relatively low consumption of red meat and moderate amounts of wine with meals. Epidemiological studies have shown that the adoption of the traditional Mediterranean diet is associated with a decreased risk of cardiovascular disease.^{24,25}

Clinical studies have supported these epidemiological observations by showing that when subjects modified their diet toward the adoption of a traditional Mediterranean diet, it was accompanied by improvements in insulin sensitivity and plasma lipid-lipoprotein profile.²⁶⁻²⁸ One of these clinical studies also demonstrated a decrease in inflammation and improvement in endothelial function.²⁸

Changing the diet towards the adoption of the traditional Mediterranean diet is feasible even in non Mediterranean populations. In fact, French Canadian women from the Quebec City area were able to modify their diet in response to a 12-week nutritional intervention aimed at the adoption of the traditional Mediterranean diet.²⁹ These changes were accompanied by significant decreases in apolipoprotein B and oxidized LDL concentrations, independently of changes in body weight.^{29,30}

Although the beneficial effects of the Mediterranean diet on the metabolic profile are observed independently of body weight, it has been shown that adoption is also associated with lower body weight.²⁹ This is probably explained by the low-energy density of the Mediterranean diet and its high satiating effect -namely because of its high fibre content.

Conclusion

The dietary management of obesity is a matter of both quantity and quality of energy intake. A body weight loss corresponding to 5 to 10 % of initial body weight has been shown to induce significant improvements in the metabolic profile of obese individuals. It is suggested that reducing energy density of the diet is useful to induce energy restriction without increasing hunger. In addition avoiding large portion sizes can also be a tool that can be valuable to control energy intake. It is also suggested that intervention aiming at improving the

accuracy of internal signals of hunger and satiety can help reduce energy intake. However, because of the multi-dimensional factors involved in body weight regulation these strategies should not be considered as the unique and "magic solution" to manage overweight problems but rather as a part of the solution for some people. Finally, considering the challenges of losing and keeping off body weight, an alternate strategy for improving metabolic health in obese individuals would be to favour modification of diet quality without necessarily achieving weight loss.

Reference List

1. Tjepkema, M. and Shields, M. Nutrition: Résultats de l'enquête sur la santé collectives canadiennes. Obésité mesurée: Obésité chez les adultes au Canada. statistique Canada. no 82-620-MWF2005001. 2006. Ottawa, Statistique Canada.
2. Wing RR, Phelan S. Long-term weight loss maintenance. *Am J Clin Nutr*. 2005;82:222S-55S.
3. Anderson JW, Konz EC, Frederich RC, Wood CL. Long-term weight-loss maintenance: a meta-analysis of US studies. *Am J Clin Nutr* 2001;Nov;74(5):579-84. 2001;74:579-84.
4. Bell EA, Rolls BJ. Energy density of foods affects energy intake across multiple levels of fat content in lean and obese women. *Am J Clin Nutr* 2001;73:1010-8.
5. Rolls BJ, Bell EA, Castellanos VH, Chow M, Pelkman CL, Thorwald ML. Energy density but not fat content of foods affected energy intake in lean and obese women. *Am J Clin Nutr*. 1999;69:863-71.
6. Ello-Martin JA, Roe LS, Ledikwe JH, Beach AM, Rolls BJ. Dietary energy density in the treatment of obesity: a year-long trial comparing 2 weight-loss diets. *Am J Clin Nutr* 2007;85:1465-77.
7. Latner JD, Schwartz M. The effects of a high-carbohydrate, high-protein or balanced lunch upon later food intake and hunger ratings. *Appetite* 1999;33:119-28.
8. Mellinkoff SM, Frankland M, Boyle D, Greipel M. Relationship between serum amino acid concentration and fluctuations in appetite. *J Appl Physiol* 1956;8:535-8.
9. Westertep-Plantenga MS, Rolland V, Wilson SA, Westertep KR. Satiety related to 24 h diet-induced thermogenesis during high protein/carbohydrate vs high fat diets measured in a respiration chamber. *Eur J Clin Nutr* 1999;53:495-502.
10. Hall WL, Millward DJ, Long SJ, Morgan LM. Casein and whey exert different effects on plasma amino acid profiles, gastrointestinal hormone secretion and appetite. *Br J Nutr* 2003;89:239-48.
11. Rolls BJ, Morris EL, Roe LS. Portion size of food affects energy intake in normal-weight and overweight men and women. *Am J Clin Nutr* 2002;76:1207-13.
12. DiIberti N, Bordini PL, Conklin MT, Roe LS, Rolls BJ. Increased portion size leads to increased energy intake in a restaurant meal. *Obes Res*. 2004;12:562-8.
13. Rolls BJ, Roe LS, Kral TV, Meengs JS, Wall DE. Increasing the portion size of a packaged snack increases energy intake in men and women. *Appetite* 2004;42:63-9.
14. Rolls BJ, Roe LS, Meengs JS. Larger portion sizes lead to a sustained increase in energy intake over 2 days. *J Am Diet Assoc*. 2006;106:543-9.
15. American Institute for Cancer Research. New survey on portion size: Americans still cleaning plates. 2006. American Institute for Cancer home page: www.aicr.org (accessed 13 December 2007).
16. Kant AK, Graubard BI. Eating out in America, 1987-2000: trends and nutritional correlates. *Prev Med* 2004;38:243-9.
17. Long SJ, Hart K, Morgan LM. The ability of habitual exercise to influence appetite and food intake in response to high- and low-energy preloads in man. *Br J Nutr* 2002;87:517-23.
18. Davy BM, Van Walleghen EL, Orr JS. Sex differences in acute energy intake regulation. *Appetite* 2007;49:141-7.
19. Provencher V, Bégin C, Tremblay A, Mongeau L, Boivin S, Lemieux S. Short-term effects of a "health-at-every-size" approach on eating behaviors and appetite ratings. *Obesity (Silver Spring)* 2007;15:957-66.
20. Phelan S, Wadden TA, Berkowitz RI et al. Impact of weight loss on the metabolic syndrome. *Int J Obes (Lond)* 2007;31:1442-8.
21. Weickert MO, Mohlig M, Schöffl C et al. Cereal fiber improves whole-body insulin sensitivity in overweight and obese women. *Diabet Care* 2006;29:775-80.
22. He FJ, Nowson CA, MacGregor GA. Fruit and vegetable consumption and stroke: meta-analysis of cohort studies. *Lancet* 2006;367:320-6.
23. Lichtenstein AH, Appel LJ, Brands M et al. Diet and lifestyle recommendations revision 2006: a scientific statement from the American Heart Association Nutrition Committee. *Circulation* 2006;114:82-96.
24. Keys A, Menotti A, Karvonen MJ et al. The diet and 15-year death rate in the seven countries study. *Am J Epidemiol*. 1986;124:903-15.
25. Trichopoulos A, Costacou T, Bamia C, Trichopoulos D. Adherence to a Mediterranean diet and survival in a Greek population. *N Engl J Med* 2003;348:2599-608.
26. Vincent-Baudry S, Defoort C, Gerber M et al. The Medi-RIVAGE study: reduction of cardiovascular disease risk factors after a 3-month intervention with a Mediterranean-type diet or a low-fat diet. *Am J Clin Nutr*. 2005;82:964-71.
27. de Lorgeril M, Salen P, Martin JL, Monjaud I, Delaye J, Mamelle N. Mediterranean diet, traditional risk factors, and the rate of cardiovascular complications after myocardial infarction: final report of the Lyon Diet Heart Study. *Circulation* 1999;99:779-85.
28. Esposito K, Marfella R, Ciotola M et al. Effect of a mediterranean-style diet on endothelial dysfunction and markers of vascular inflammation in the metabolic syndrome: a randomized trial. *JAMA* 2004;292:1440-6.
29. Goulet J, Lamarche B, Nadeau G, Lemieux S. Effect of a nutritional intervention promoting the Mediterranean food pattern on plasma lipids, lipoproteins and body weight in healthy French-Canadian women. *Atherosclerosis* 2003;170:115-24.
30. Lapointe A, Goulet J, Couillard C, Lamarche B, Lemieux S. A nutritional intervention promoting the Mediterranean food pattern is associated with a decrease in circulating oxidized LDL particles in healthy women from the Quebec City metropolitan area. *J Nutr* 2005;135:410-5.

