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TREATMENT OF OBESITY

Is There an Optimal Diet for Weight Management and Metabolic Health?

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Individuals can lose body weight and improve health status on a wide range of energy (calorie)-restricted dietary interventions. In this paper, we have reviewed the effectiveness of the most commonly utilized diets, including low-fat, low-carbohydrate, and Mediterranean approaches, in addition to commercial slimming programs, meal replacements, and newly popularized intermittent fasting diets. We also consider the role of artificial sweeteners in weight management. Low-fat diets tend to improve low-density lipoprotein cholesterol the most, while lower-carbohydrate diets may preferentially improve triglycerides and high-density lipoprotein cholesterol. However, differences between diets are marginal. Weight loss improves almost all obesity-related co-morbidities and metabolic markers, regardless of the macronutrient composition of the diet, but individuals do vary in preferences and ability to adhere to different diets. Optimizing adherence is the most important factor for weight loss success, and this is enhanced by regular professional contact and supportive behavioral change programs. Maintaining weight losses in the long term remains the biggest challenge, and is undermined by an "obesogenic" environment and biological adaptations that accompany weight loss.

Keywords: Obesity; Diet; Weight Loss; Type 2 Diabetes; Sweeteners.

Few areas of nutritional science have divided opinion as much as the controversies around the optimal diet for successful weight management and good health. Obesity rates are at an all-time high, with more than two thirds of adults classified as overweight (body mass index [BMI] >25 kg/m^2) or obese (BMI >30 kg/m^2) in most of the Western world. The epidemic of obesity is considered the biggest global public health problem of this generation. It is well established that obesity shortens life span and carries a heavy secondary chronic disease burden. It is an important risk factor for several major causes of preventable death and pathology, including type 2 diabetes (T2DM), hypertension, cardiovascular disease, arthritis, several cancers, non-alcoholic fatty liver disease, sleep apnea, gallbladder disease, and depression, as well as a host of troublesome and expensive symptoms, including breathlessness, edema, and indigestion. Obesity is thus responsible for most of the total costs to be met by healthcare providers or insurers. Clinically important consequences of obesity can be considerably improved with as little as 5%–10% body weight loss, which is achievable by many methods, but this rarely satisfies the wishes of patients.[1] Remission of conditions such as sleep apnea and T2DM typically require 15–20 kg weight loss,[2,3] which is also more acceptable to people living with obesity.

Debates regarding the optimal diet have ensued between scholars, which at times has descended to statements of belief more akin to religions than to scientific arguments based on evidence. Are carbohydrates inherently fattening? Does excess saturated fat lead to heart disease? Will fasting help you live longer? What about gluten? At the time of this writing, an Internet search using the term "diet for weight loss" returns nearly 51 million results and a similar search on Amazon yields more than 31,000 books on the topic. This proliferation of dietary (mis)information is driven primarily by a multi-billion dollar fad-diet industry and commercial diet providers. The US weight loss market was said to be worth $60 billion in 2014.[4] Few options are evidence based, and this volume of competing unregulated information highlights how easily individuals seeking to lose weight could be misled. Mark Twain once said "be careful of reading health books, you may die of a misprint." Even scientists, inadvertently or otherwise, can end up promoting dietary practices that lack a solid evidence base.

Abbreviations used in this paper: **ADF, alternate day fasting; BMI, body mass index; CER, continuous energy restriction; DPP, Diabetes Prevention Program; IER, intermittent energy restriction; LCD, low carbohydrate diet; LDL, low-density lipoprotein; LFD, low-fat diet; MSD, Mediterranean style diet; RC, restricted carbohydrate; RCT, randomized controlled trial; T2DM, type 2 diabetes; VLCD, very low calorie diet.**

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Broadly speaking, body weight status depends on a complex inter-play between 3 powerful forces – the environment in which we live, our genes, and our behaviors, obligatory or chosen in relation to eating and exercise. Genetics cannot be changed, but epigenetics can. Although modifying the food environment would be most effective in terms of prevention, it is unlikely to occur soon, therefore dietary intervention remains the cornerstone of management. Much is known about strategies for weight loss, but much is still to be learned about an optimal approach for weight loss maintenance. This paper reviews the key evidence-based dietary interventions for weight loss and maintenance with reference to macronutrient composition, and impact on metabolic health. Pharmaceutical and surgical interventions are not discussed here, but both still ultimately depend on improving diet.

Calorie Restriction for Weight Loss

Assuming that most people cannot maintain physical activity outputs of athletes, people who are overweight and obese must consume more calories than thinner people to avoid weight loss, and weight loss can (realistically) only be achieved with reduced energy consumption. The properties of the 3 main macronutrients - carbohydrates, protein, and fat are listed in Table 1.[5] Whether a diet is targeted toward reducing fat or carbohydrate, or increasing protein, for weight loss to occur an energy deficit must be established. This "energy in/energy out" model of obesity hinges on the first law of thermodynamics, that energy can neither be created nor destroyed. Therefore, all calories entering the body must be oxidized as fuel or stored as adipose tissue. Weight gain occurs when energy intake exceeds energy expenditure, and energy balance and weight stability is achieved when these two factors are matched over time. In theory, energy restriction sounds simple; however, there are complex and tightly regulated processes with interacting environmental and (epi-)genetic factors and secondary homeostatic endocrine[6] and behavioral responses that oppose weight loss. Consequently, maintenance of lost weight and achieving a state of energy balance following a period of deliberate energy restriction presents a formidable challenge.

Table 1. Characteristics of the Main Macronutrients: Fat, Protein, and Carbohydrate

	Fat	Protein	Carbohydrate
Ability to bring eating to an end	Low	High	Intermediate
Ability to suppress hunger	Low	High	High
Contribution to daily energy intake	High	Low	High
Energy density	High	Low	Low
Storage capacity in the body	High	None	Low
Metabolic pathway to transfer excess intake to another compartment	No	Yes	Yes
Autoregulation (ability to stimulate own oxidation on intake)	Poor	Good	Good
Calories per gram	9	4	3.75

NOTE. Alcohol (7 kcal/g) is inappropriate as a contributor to a weight-management diet.
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Some authors present a simplistic argument that insulin regulates fat accumulation and weight gain while hyperinsulinemia, characteristic of obesity, reduces mobilization of fatty acids by inhibiting hormone-sensitive lipase.[7,8] This argument neglects the imperative of energy restriction. Others report a "metabolic advantage" for low carbohydrate diets (LCD), suggesting that calorie for calorie, restriction of carbohydrate leads to greater fat loss by virtue of increased thermogenesis, in addition to altered metabolism.[9] The theory is that to lose body fat, carbohydrate as a primary driver of insulin secretion must be restricted so as insulin secretion falls fatty acids are mobilized and weight loss ensues. Although plausible, this interpretation is overly simplistic. Studies have conclusively demonstrated that in weight management terms, caloric restriction below metabolic requirements is fundamental for weight loss.

This principle was validated by numerous inpatient feeding studies, where energy intake was tightly controlled and energy expenditure calculated using gold standard techniques. For instance, data collected over 80 years ago by Keeton and Bone[10] under metabolic ward conditions in 9 obese subjects demonstrated no increase in energy expenditure on an energy-restricted, higher protein diet (90 g/day) when compared with a lower protein diet (13 g/day), followed in crossover fashion. Weight loss was comparable between the diets and commensurate with caloric restriction (approximately 45% below basal requirements). Werner et al[11] compared an isocaloric, high-calorie diet (287 g/day) with a LCD (52 g/day) in 6 inpatient subjects who each experienced similar results. Continuing this theme, Olesen and Quaade[12] reported identical weight losses of 4.1 kg when subjects followed LCDs (32% protein/50% fat/18% carbohydrate) and high-calorie diets (32% protein/18% fat/50% carbohydrate) for 21 days each in a crossover design study whereby energy intake was held constant at 1000 kcals/day. Further evidence was reported by Golay and colleagues,[13] who admitted 43 obese subjects each to receive a 1000 kcal/day diet, but were randomly allocated either to a relatively high (115 g/day) or low (37 g/day) carbohydrate diet. Weight losses were 7.5 kg and 8.9 kg, respectively, which were not significantly different. A slightly higher weight loss with a LCD can be explained entirely by the accompanied glycogen depletion and water loss that occur with marked carbohydrate restriction. The body can store approximately 500 g of glycogen (about 100 g in liver, 400 g in muscle), and each gram of glycogen is stored with approximately 3 g of water. When carbohydrate is severely restricted, glycogen stores are utilized to maintain blood glucose. During the first 1–2 weeks of a LCD, it is