Module 23.1
Nutrition and Prevention of Obesity

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Learning Objectives

- Early life strategies in the prevention of obesity
- Risk factors related to obesity
- How lifestyle modification can prevent the development of obesity
- Effect of nutrients on obesity

Contents

Key Messages

- Obesity is one of the major health problems of today and is associated with increased risk of several diseases both in frequency and severity;
- The development of obesity is determined by both genetic and environmental factors;
- Generally breastfed infants tend to have a lower BMI than formula-fed infants and behavioral and hormonal mechanisms may explain this difference;
- Sedentary behavior (viewing television, playing video games, doing cognitive work, and listening to music) and reduced overall physical activity along with shorter sleep duration promote the overconsumption of dietary macronutrients leading to obesity;

- Physical activity or exercise in a sufficient dose seem to better facilitate long-term maintenance of the new lower body weight after successful dieting;
- Low glycemic index diets do not show any consistent effect of lower weight maintenance after 12 months;
- A negative energy balance is the crucial parameter in regard to weight loss and prevention of obesity.

1. Introduction

Obesity, one of the major health problems of today, is a condition in which fat is accumulated to excess, and body weight and fat percentage are increased. As obesity is associated with increased risk of several diseases (e.g. type 2 diabetes, certain cancers, and cardiovascular diseases) (1-3), and with a worse prognosis once disease occurs, it is relevant to target the excess of fat accumulation and prevent lifetime body-weight gain.

The epidemic of excess weight and obesity is a global health problem contributing to an ever-increasing non-communicable disease burden. Chronic overfeeding seems to be the most important factor leading to obesity (4). There are additional causal factors, such as genetic disposition, sedentary lifestyle and impairment of mechanisms that could protect an individual against excessive fat storage after overfeeding. Among such mechanisms are postprandial thermogenesis, non-exercise related thermogenesis, physical activity, composition of muscle fibers, thyroid hormone activity, etc. Risk factors for obesity include parental fatness, social factors, birth weight, timing or rate of maturation, physical activity, dietary factors and other behavioral or psychological factors.

Childhood obesity is a major health problem not only in the United States and the other western countries but now also in developing countries throughout the world. In Europe, about 20% of children are overweight. The most recent National Health and Nutrition Examination Surveys (NHANES) indicate that childhood obesity in the United States has approximately doubled during the past three decades, and adolescent obesity has more than tripled during the same period (5). Moreover, it should be noted that some epidemiological studies indicate that the prevalence of childhood obesity is continuing to increase in certain sex, age, ethnic, and socioeconomic status groups within the United States and that the current childhood obesity epidemic will contribute to an increase in the number of obese adults (6).

The prevalence of excess weight and obesity have increased dramatically in the United States and around the world.[7] More than one-third of adults (35.5% men and 35.8% women) and almost one fifth (17%) of youths in the United States are obese, although the prevalence remained stable between 2003-2004 and 2009-2010, and recent data suggested a slowing or leveling off of these trends (7). The increases in the prevalence of obesity previously observed do not appear to be continuing at the same rate over the past 10 years, particularly for women and possibly for men (8). However, obesity prevalence remains high and thus it is important to continue surveillance (9). Although the prevalence of childhood obesity increased in the 1980s and 1990s there were no significant changes in prevalence between 1999-2000 and 2007-2008 in the United States (5).

In the developed world, more than 40% of citizens are overweight, and over 20% are obese; in some countries as many as three quarters of the adult population are overweight. Thus, weight control is a national and global priority especially in those areas. The steep rise in the incidence of obesity in the developed world, when the genetic background has not changed, is due to excess intake of energy and diminishing levels of activity. It is also probable that the thrifty gene hypothesis plays a part (10).

It is obvious that those individuals who survived to the 20th century are the descendants of those who could cope best with shortage of food (during wars or famine), due to their highly efficient storage and energy conserving mechanisms. Nowadays, with shortage of food no longer being a problem for developed and developing countries, humans tend to develop obesity easily and then suffer from its consequences. This is due mainly to the fact that mammals have a variety of mechanisms to adapt to low intake of food (e.g. including reduced energy expenditure), but mechanisms to counteract excess energy intake are, on the other hand, limited to increased physical activity. Nevertheless, it has been shown in studies both in animal models and humans, that after a period of excess intake of energy, body weight tends to return to its usual value.

The classification of obesity is accepted worldwide according to the BMI and is defined as a BMI >30 kg/m^2. It can be used as an indicator of life expectancy and of the risk of most of the complications of obesity. The optimal BMI in terms of life expectancy seems to be between 20-22 kg/m^2 in young adults, while health risks of increased body weight rise progressively with a BMI higher than 25 kg/m^2. Morbid obesity (BMI >40 kg/m^2) is considered a serious disease and such patients rarely live longer than 60 years (11). Other studies have found that a dynamic measure of weight status (weight or BMI change) is more predictive of mortality than is a static measure of weight status (i.e., baseline BMI), especially among older adults (12,13). An exception to this rule is posed by overweight/obese patients in the ICU and/or with renal insufficiency, among whom a moderately higher BMI is related to longer survival, which accounts for the so called "obesity paradox" (see relevant modules).

Nonetheless, in addition to the weight or BMI, the level of activity seems also to be closely related to mortality in obese patients. In sumo wrestlers, who are chronically overfed while highly active, their increased muscle mass gets quickly replaced by adipose tissue when they quit exercising. Therefore it is not obviously better to be obese but physically fit (fit-fat) rather than slim but unfit (unfit-lean) (11).

Additionally, the type of obesity seems to be important, since the android type of obesity leads to significantly more frequent metabolic complications (e.g. development of diabetes and atherosclerosis). A ratio between waist and hip circumferences (WHR) of >1 can be used as an index of android obesity, although waist circumference alone correlates better with the amount of visceral fat. Therefore the risk of metabolic complications, equates with the predisposition to develop an android type of obesity, and is related to an increased waist circumference(14) which is usually classified as mild or severe.

Although obese individuals use fat as their main source of energy, this is also influenced by the pattern of substrate intake. Obese subjects have higher absolute energy expenditure due to their increased mass and the work of moving their heavier bodies, although oxygen consumption per kilogram of body weight may be lower than in normal weight individuals, since adipose tissue has a lower metabolic rate than lean tissue. Some obese subjects also have lower diet-induced thermogenesis (see Module 3).

2. Prevention of Obesity

2.1 Genetics of Obesity

The development of obesity is determined by both genetic and environmental factors (1,2). It is clear that some individuals are more prone to gain body weight when they are exposed to a given diet, because of susceptibility from a specific genetic background. Research regarding the influence of genetics on obesity has expanded in the recent years, however clear results are not yet available to assist our understanding of the interactions that impact on body weight and weight

management. Additionally the failure to maintain body weight after initial successful weight loss as a result of a specific diet may be ascribed in part to genetic factors.

2.2 Early Prevention of Obesity

The prevention of obesity seems to be an easier and more effective target rather than losing weight after already becoming overweight or obese. There are sufficient data showing that factors contributing to obesity later in life are already present at the time of gestation. Additionally, the first months of life and in particular the quality and the quantity of the calories received during this first period of life seem to play an important role in the development of later obesity. Therefore it is important to identify modifiable risk factors for early childhood overweight in order to develop effective prevention or intervention programs. The position paper of the American Academy of Nutrition and Dietetics states that primary prevention is the most effective, affordable method to prevent chronic disease, and that dietary intervention positively impacts on health outcomes across the lifespan (15).

Besides biological factors, familial interactions and parental behavioral patterns may influence children's weight development. Longitudinal investigation of children at overweight risk could help to detect significant risk and protective factors (16). Offspring of obese parent(s) are consistently seen to be at increased risk of fatness, although few studies have looked at this relationship over longer periods of childhood and into adulthood. Additionally, a study focusing on whether parental responsibility is an effective method in weight control interventions in children, concluded that reviewing the intensity of parental involvement and behavior change techniques are important issues in the effectiveness of long-term childhood weight control interventions (17).

Overall, it is important to avoid overweight or obesity, and this can start from the early stages of life. The Position Paper on the interventions for the prevention and treatment of pediatric overweight and obesity of the Academy of Nutrition and Dietetics addresses this very important topic (18). Prevention and treatment of pediatric overweight and obesity require systems-level approaches that include the skills of registered dietitians, as well as consistent and integrated messages and environmental support across all sectors of society to achieve sustained dietary and physical-activity behavior change (18). Early childhood and school-based interventions should integrate behavioral and environmental approaches that focus on dietary intake and physical activity using a systems-level approach targeting the multilevel structure of the socio-ecological model as well as interactions and relationships between levels. Secondary prevention and tertiary prevention/treatment should emphasize sustained family-based, developmentally appropriate approaches that include nutrition education, dietary counseling, parenting skills, behavioral strategies, and physical-activity promotion. Policy and environmental interventions are recommended as feasible and sustainable ways to support healthful lifestyles for children and families.

One study evaluated the influence of adulthood weight history on mortality risk and found that BMI at age 18 years was strongly positively related to total mortality in men and women (19). Weight gain was positively related to mortality, with stronger associations for gain between ages 18 and 35 years and ages 35 and 50 years than between ages 50 and 69 years. Mortality risks were higher in persons who attained or exceeded a BMI of 25.0 kg/m^2 at a younger age than in persons who reached that threshold later in adulthood, and risks were lowest in persons who maintained a BMI below 25.0 kg/m^2. Higher BMI and weight gain in early to middle adulthood strongly predicted mortality risk in persons aged 50–69 years (19). These results suggest that excess weight-related mortality may be reduced among persons who enter adulthood with a low BMI, avoid gaining weight with age, and maintain a body mass within the healthy range over the course of adulthood. Public health efforts should encourage weight control in early and middle adulthood (19).

2.3 Obesity and Early Life Strategies

Breastfed infants tend to have a lower BMI than formula-fed infants and behavioral and hormonal mechanisms may explain this difference. The theory is that a high nutrient diet in infancy adversely programs the principal components of the metabolic syndrome in the child (body mass index, blood pressure and blood lipids) by promoting growth acceleration, whereas faster growth promotes later cardiovascular disease and its risk factors (20). The higher protein content of infant formulas compared to the lower protein content in breast milk might be responsible for the increased growth rate and adiposity of formula-fed infants during the most influential periods of infancy. During late infancy many such infants have a protein intake which is more than three times as high as the actual need. Several observational studies have shown an association between a high-protein intake (>15% energy) early in life, and an increased risk of developing obesity and thereby non-communicable diseases (NCDs) later (21,22).

It is plausible that an important reason for the slower growth in breast-fed infants is the lower content of protein in breast milk, but other qualities of breast milk could also play a role. A high intake of protein, especially dairy protein, stimulates the growth factors, insulin-like growth factor (IGF-I) and insulin, and it has been suggested that the lower risk of NCDs seen in breast-fed infants is mediated through regulation by IGF-I. Follow-up at 2 years of age shows that a lower protein supply from milk formula can normalize early growth relative to a breast fed reference group and to the WHO growth reference values. These results demonstrate that a modification of the infant feeding practices could have a potential impact on long-term health promotion (23). This could lead to an update in regard to the recommendations and policies for infant formula composition.

Future research on the relationship between breastfeeding, timely introduction of complementary feeding, and rapid weight gain and obesity are warranted in developing countries (24). The focus of interventions to reduce the risk of obesity in later life could include:

- improving maternal nutritional status during pregnancy to avoid low birth weight
- enhancing breastfeeding (including durations of exclusive and total breastfeeding)
- timely introduction of high-quality complementary foods (containing micronutrients and essential fats but not excessive in protein).

Further evidence is needed to understand to what extent weight gain and length gain during early childhood are actually related to body composition later in life (24).

Although a person's BMI typically tracks over time (i.e. tends to be in a similar percentile range as the person ages), longitudinal genetic studies suggest that such tracking may be primarily a function of genotype rather than a persistent effect of early learning or habits (25). No randomized, controlled clinical trials provide evidence to the contrary (26).

3. Obesity and Health

Attempts to achieve normal weight seem to be not only unrealistic but most importantly unnecessary, since even a moderate weight loss (5-10% of BW) predominantly affects splanchnic fat and demonstrates important functional effects, by significantly decreasing the incidence of diabetes mellitus Type-2 (by 50%), the incidence of some tumors (by 50%), and reducing cardiovascular mortality (by 20%) (11). These positive effects can probably be associated with fine-tuning of adipose tissue function and do not seem to be amplified further by any additional weight loss.

Furthermore, two studies showed that interventions designed to improve weight-loss outcomes by altering unrealistic goals resulted in more realistic weight-loss expectations but did not improve outcomes (26). On the other hand, several studies have shown that more ambitious goals are sometimes associated with better weight-loss outcomes (27).

3.1 Obesity and Mortality Risk

Little research has addressed the heterogeneity and mortality risk in BMI trajectories among older populations. On applying latent class trajectory models to 9,538 adults aged 51 to 77 years from the US Health and Retirement Study (1992-2008), 6 latent BMI trajectories were defined: normal weight downward, normal weight upward, overweight stable, overweight obesity, class I obese upward, and class II/III obese upward. The results were as seen below (28). People in the overweight stable trajectory had the highest survival rate > followed by those in the overweight obesity > normal weight upward > class I obese upward > normal weight downward, and > class II/III obese upward trajectories. Further analysis suggested that BMI trajectories were more predictive of mortality risk than was static BMI status. The differences between the overweight stable and overweight obesity trajectories were not statistically significant, a finding that suggests that in overweight people >51 years of age, small BMI gains do not negatively impact the probability of survival. By contrast, a BMI gain in obese people (either class I or class II/III obese) negatively influences their mortality risk. As it can be extrapolated the impact of a weight (or BMI) gain to mortality risk depends on baseline BMI status (28).

Many previous studies have found that weight gain was associated with a higher mortality risk in overweight/obese individuals (28). These findings indicate that the associations of weight gain with mortality risk depend on baseline BMI status. Paradoxically, it appears that weight loss, even a small one (a decrease of approximately 1 BMI unit), in a person in the normal weight category, can potentially have a significant deleterious effect on health. Previous studies found that even small weight losses can exert a harmful effect on survival, regardless of the initial BMI level (29).

Individuals in the underweight and class II/III obese categories had increased mortality risk compared with the reference category (overweight). Normal weight and class I obesity were not associated with significant increases in mortality risk. These findings are consistent with those from the analysis by Mehta and Chang (30).

3.2 Obesity and Metabolic Complications

The adipose tissue of a lean individual eating healthy food and exercising regularly consists of small adipocytes secreting a whole spectrum of hormones (e.g. adiponectin) which act protectively against insulin resistance and atherogenesis (31). It also has sufficient reserve capacity to store substrates postprandially, in that way protecting the key metabolic organs (such as liver, pancreas and muscles) against a lipid overload and ectopic lipid storage. On the contrary, the adipose tissue of an obese individual presented with an unhealthy diet and sedentary life style is associated with metabolic complications and health problems (4,14).

Table 1

The consequences of chronic overfeeding

Metabolic and organ changes connected with chronic overnutrition
• Production of fat, steatosis of liver, muscles and pancreas • Obesity • Excessive secretion of fat cell hormones, fatty acids and cytokines • Insulin resistance • Metabolic syndrome incl. type 2 diabetes, hypertension and hyperlipidemia • Impaired coagulation and fibrinolysis – thrombotic complications • Sterility and hormonal disorders • Sleep apnea syndrome • Respiratory failure • Impaired regeneration and wound heeling • Infections • Atherosclerosis, endothelial dysfunction, cardiovascular diseases • Oxidative stress • Obesity-related tumors • Diabetes mellitus • Depression

4. Obesity in Everyday Life

4.1 Obesity and Lifestyle

A number of recent studies suggest that both sedentary behavior (viewing television, playing video games, doing cognitive work, and listening to music) and reduced overall physical activity along with shorter sleep duration, promote the overconsumption of dietary macronutrients, particularly fats and refined carbohydrates (32-35). Sedentary behavior in both young and adult age has been implicated in being overweight and obese. However, the relationship is often small or inconsistent, whereas few studies have checked for confounding factors such as diet and physical activity. In a recent systematic review it was revealed that sedentary behavior, usually assessed as screen time and predominantly TV viewing, is associated with unhealthy dietary behaviors in children, adolescents, and adults. Interventions need to be developed that target reductions in sedentary time to test whether diet also changes (36).

On the other hand, being constantly attracted by commercials favoring less healthy food products, it is quite difficult to make the correct choice. In various western countries an additional taxation for less health food choices has come under consideration. Such a taxation is commonly proposed as a mechanism to reduce consumption of poor food choices and hence reduce rates of obesity and overweight in the community (37). Relevant data from countries implementing such activities are expected to show whether the obesity epidemic can be reversed or lowered.

4.2 Body Weight Gain vs. Body Weight Maintenance

Maintenance of body weight is achieved when energy intake is adjusted to energy expenditure. Usually, in those previously overweight, the pitfall appears to be body-weight regain after initial weight loss (3). Body weight increases as a result of a positive energy balance, which occurs when energy intake exceeds energy expenditure. The desired goal for the treatment of overweight or obesity and avoiding subsequent body-weight gain is to decrease fat mass whilst preserving or increasing fat free mass. The targeted higher ratio of fat free mass to fat mass plays an important role in the maintenance of neutral energy balance and stable body weight,

since fat free mass is the main determinant of basal energy expenditure (38), and of the preservation of metabolic and overall health (39,40).

Studies have shown that maintaining the new lower weight after a negative energy balance diet is a very difficult task, often resulting in a higher weight than before the diet. Adapting to a new dietary regimen alone does not seem enough to permit maintenance of the new lower weight. A new approach, including increased physical activity, recording of dietary intake and a supportive social environment, together seem to be the best way to achieve the desired result.

Finally, a recent systematic review demonstrated that physical activity or exercise in sufficient amount seems to better facilitate long-term maintenance of the new lower body weight (41). In general, as reported by a recent meta-analysis, a continuation of the conditions that promoted weight loss also promote a better degree of maintenance of the lower weight (42).

5. Effects of the nutrients on obesity

In diets designed to prevent and treat obesity by manipulating energy content, macronutrient distribution was commonly set at 15% protein, <30% lipids, and 50–55% carbohydrates, with reductions in dietary fat and increases in fiber favored (43). Although this recommendation seemed to be effective for decreasing energy density and promoting weight loss in the short term, the low level of observed satiety it achieved decreased dietary adherence over longer periods (44). On the other hand, some authors raise concerns in respect of the diet composition, inferring that a negative energy balance is the (only) crucial parameter (45).

Macronutrients do not have equal effects on satiety. Protein seems to have the greatest satiating effect, while fat the least intense. Parallel to this is the sequence of priority with respect to metabolism of macronutrients (46). Postprandial energy expenditure of a mixed meal is in the main oxidation of carbohydrates and proteins followed then by fat oxidation in the fasted state.

5.1 Obesity and Protein intake

The World Health Organization (WHO) recommends that dietary protein should account for around 10-15% of energy when individuals are in energy balance and of stable weight. However, in regard to the role of dietary protein in body-weight loss and body-weight maintenance, absolute protein intake seems to be more important than the proportion of protein in the diet.

High protein diets might have an effect on total energy intake and body composition. An increase of the relative protein content of a diet (e.g. from 10-15% of energy to 20-30%) might lead to a reduction in food intake under *ad libitum* conditions, resulting in immediate body-weight loss. Increasing the protein content of a diet might also increase the chance of maintaining the new body weight (after body-weight loss). This is mainly due to the fact that this increase in the relative protein content of the diet promises to reduce the risk of a positive energy balance and the development of obesity. A recent multicenter study found that a higher protein content of an *ad libitum* diet can improve weight loss maintenance in overweight and obese adults over 12 months (47).

5.2 Obesity and Fat Intake

The optimal intake of total fat was debated at the Joint Food and Agriculture Organization of the United Nations/World Health Organization expert consultation on fats and fatty acids in human nutrition held in November 2008 (48).

A study focusing on the relation between total fat intake and body weight in adults and children investigated 33 randomized controlled trials (73,589 participants) and 10 cohort studies, all from developed countries (49). A lower total fat intake was found to account for small but statistically significant and clinically meaningful sustained reductions in body weight in adults in studies with baseline fat intakes of 28-43% of total energy intake and durations from 6 months to >8 years. Lowering total fat intake in adults was associated with a reduction in body weight, BMI and WC both for healthy adults and those with risk factors or current illness. Although the evidence was slightly less strong in children, diets higher in total fat seem to be associated with higher body weight, body mass index, and waist circumference in both adults and children (49).

Calorie restriction in general, can achieve short-term weight loss but the weight loss has not been shown to be sustainable in the long-term. An alternative approach to calorie restriction is to lower the fat content of the diet. However, the long-term effects of fat-restricted diets on weight loss have not been established. A review suggested that fat-restricted diets are no better than calorie restricted diets in achieving long-term weight loss in overweight or obese people. Overall, participants lost slightly more weight on the control diets but this was not significantly different from the weight loss achieved through dietary fat restriction and was so small as to be clinically insignificant (50).

5.3 Obesity and Dietary Sugars

Sugar has been a component of human diets since ancient times. The role of dietary sugars in the current obesity epidemic is much debated and opposing views can be found in the lay as well as scientific literature (51). The most obvious mechanism by which increasing sugars might promote weight gain is by increasing energy consumption to an extent that exceeds energy output leading to a positive energy balance (52). In this meta-analysis it was proposed that intake of sugars is a determinant of body weight in people consuming ad libitum diets. The data suggest that the change in body fatness that occurs with modifying intake of sugars results from an alteration in energy balance rather than a physiological or metabolic consequence of monosaccharides or disaccharides (52). However, when considering the rapid weight gain that occurs after an increased intake of sugars, it seems reasonable to conclude that advice relating to sugar intake is a relevant component of a strategy to reduce the high risk of overweight and obesity in most countries.

Studies with respect to the association between intake of dietary sugars and body weight in adults and children reported that among people consuming ad libitum diets, intake of free sugars or sugar-sweetened beverages is a determinant of body weight. The change in body fatness seems to be mediated from changes in energy intake, since isoenergetic exchange of sugars with other carbohydrates was not associated with weight change (52).

Regarding sugar-sweetened beverages (SSBs) which are the single largest source of added sugar and the top source of energy intake in the U.S. diet, scientific evidence suggests that decreasing SSB consumption leads to reduced prevalence of obesity and its related diseases (53,54). Prevention of long-term weight gain through dietary changes such as limiting consumption of SSBs is more important than short-term weight loss in reducing the prevalence of obesity in the population. This is due to the fact that once an individual becomes obese, it is difficult to lose weight and keep it off (53).

Similar results, correlated with higher BMI were found also for younger children (2-5 years old) consuming SSB. Pediatricians and parents should discourage SSB consumption to help avoid potential unhealthy weight gain in young populations. From a public health standpoint, strong consideration should be made toward policy changes leading to decreases in SSB consumption among children (55).

5.4 Obesity and Dairy Products

Several observational and experimental studies have focused on the effect of dairy consumption on weight and body composition, however results are inconsistent. The consumption of dairy products might facilitate weight loss and fat loss because dairy products contain calcium, protein (casein and whey), and other bioactive compounds that may favorably affect energy balance. Recent data do not support a beneficial effect of increasing dairy consumption on weight loss and fat loss in long-term studies or studies without energy restriction (56,57). However, dairy products may have modest benefits in facilitating weight loss in short-term or energy-restricted RCTs (56), also with significantly lower body fat mass, lean mass and waist circumference (WC) compared with those in the usual weight loss diets (57).

5.5 Obesity and Dietary Salt

In a large study (4283 Australian children, age 2-16 years) which was recently published the associations between dietary salt, fluid, and SSB consumption and weight status were examined (58). Dietary salt intake was positively associated with fluid consumption and each additional 1 g/d of salt was associated with a 46 g/d greater intake of fluid (not always water). Naturally, in those consuming SSBs, salt intake was positively associated with increased SSB consumption (each additional 1 g/d of salt was associated with a 17 g/d greater intake of SSB). Furthermore, SSB consumption was associated with higher risk of developing obesity. Therefore, in addition to the known benefits of lowering blood pressure, salt reduction strategies may also be useful in childhood obesity prevention efforts (58).

5.6 Obesity and Glycemic Index / Load

It has been suggested that low glycemic index (GI) or low glycemic load (GL) diets may stimulate greater weight loss than higher GI or higher GL diets or other weight reduction diets. In studies comparing ad libitum low GI diets to conventional restricted energy low-fat diets participants performed equally well or better on the low GI diet, even though they could eat as much as desired. Overweight or obese people on low GI diets tend to benefit more in regard to weight loss and blood lipid profiles than those receiving regular diets. Lowering the GI of the diet appears to be an effective method of promoting weight loss and can be relatively simply incorporated into a person's lifestyle (59). However, with regard to the long-term effects of low GI diets, results from a recent multicenter study did not show any consistent effect of GI on weight regain after 12 months (47).

6. Summary

Diet and modification of physical activity are the two cornerstones for the prevention and treatment of obesity. Attempts to achieve normal weight seem to be not only unrealistic but most importantly unnecessary. Summarizing the overview of a healthy diet regime, a regular food intake divided into 3 to 6 portions, with sufficient amounts of fiber, vitamins and minerals is recommended. It should be varied and include daily portions of fruit and vegetables, whole grain products, potatoes and pulses, and avoid a positive energy balance. Change in lifestyle includes changes in leisure time pursuits, and an increase in overall physical activity should be incorporated since this seems to better facilitate long-term maintenance of the new lower body weight. In general, as reported by a recent meta-analysis, a continuation of the conditions that promoted weight loss also promote a better degree of maintenance of the lower weight (42).

Macronutrients do not act equally with regard to their satiating efficacy. Protein seems to have the greatest satiating effect, while fat has the least intense effect. Additionally, a general recommendation of a healthy macronutrient distribution (15% protein, <30% lipids, and 50–55% carbohydrates), seems to be effective in the absence of a positive energy balance; however some authors raise concerns with regard to the true importance of the diet composition, implying that a negative energy balance is the crucial parameter for avoiding an increase ion body weight and/or achieving a lower body weight.

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