

Treatment of obesity in children and adolescents. How nutrition can work?

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Obesity is the most frequent nutritional disorder [in transition and developed countries, in which](#) overweight and obesity prevalence has increased in the last decades (1,2). Excess body fat is associated with adverse metabolic complications as well as with [relevant](#) short and long-term physical and psychosocial problems (3). The knowledge [and understanding](#) of dietary risk factors during specific life periods is needed in order to design preventive measures against the increase in the obesity [rates](#) and its consequences (4).

Obesity is the result of an energy imbalance in a susceptible subject. Energy homeostasis is regulated by a complex network of neurohormonal and metabolic processes, which maintain the individual body composition status with a strong inertia. Overweight appears when persistent positive energy imbalances occur for long periods of time. Dietary risk factors for development of childhood and adolescence obesity must be evaluated with longitudinal studies as they give us the possibility to control for confounding factors and to evaluate the effect of a specific factor over time, when the children become obese (5,6).

Obesity in children and adolescents [constitute](#) a public health priority and prevention should be the optimal approach. However, prevention programmes that have been adequately assessed do not show enough evidence about their efficacy (7). We should contribute to improve the existing programmes and to develop new ones. However, in the meantime, we must also be ready to treat obese patients following evidence-based best practice criteria.

Research has been ongoing to develop effective intervention studies for obese children (8). However, it is not clear which intervention is the most effective in assisting overweight/obese children to improve body composition [without affecting growth rates](#). Standardized weight-loss interventions should be developed that would incorporate a variety of factors to improve body composition and cardiovascular risk factors (9). Interventions that focus on family involvement use consistent dietary and exercise programs, and behavioural changes should be effective methods for positive body composition changes (10).

The objective of this article is to review the available knowledge on dietary risk factors for the development of childhood obesity, to discuss different dietary treatment strategies, and to propose an evidence based approach to treat obese adolescents.

Dietary risk factor for obesity development

There are few longitudinal studies that relate overweight development and energy intake or diet composition during a controlled period in children and adolescents (11-15). Longitudinal studies carried out during long periods of time have not shown that energy intake or diet composition is related to significant differences in childhood weight gain (11-13). Protein intake during the early postnatal months has been related to increased body size and adiposity due to higher plasma levels of insulin and IGF-1 levels (16,17) and breastfeeding is associated with a lower risk of overweight and obesity in later years (18-23). Both energy and protein intakes are lower in breast-fed infants as compared with formula-fed infants, providing indirect evidence of the importance of these factors. Mechanisms by which breastfeeding affects the risk of overweight **remain** still unclear.

To assess what are the real dietary risk factors of childhood obesity, instead of a simple energy intake, we must take into account food consumption and contemporary eating patterns (elevated consumption of bakery foods, sweetened beverages, sweets or low-quality foods, the low consumption of fruit and vegetables, daily meal patterns and energy intake distribution) as well as **physical activity patterns**, socio-cultural and economic status.

The food composition of the diet has an influence on eating behaviour, and vice versa. Palatability of meals and high energy density foods are linked, promoting more energy intake due to food consumption quantity and quality. After an excessive intake of high energy density foods, compensatory eating responses may be not sufficient to suppress hunger or to delay eating. However, eating low-energy-dense foods (such as fruits, vegetables, and soups) maintains satiety, while reducing energy intake (24).

The frequency of daily meals has been inversely associated with the prevalence of overweight (25); however, no **enough** data from longitudinal studies are available. Consumption of snacks between meals and the contribution of snacking to total daily energy and fat intake have increased among children and adolescents during the last decade. It is difficult **so far** to obtain reliable information on relationships between snacking and the risk of obesity **in young people**.

The consumption of soft drinks has also increased in children over the past decades. The greater the sweetened drink consumption, the greater is the weight gain (26). This is explained by the observation that children fail to reduce solid food

consumption, which is needed in order to compensate for the caloric contribution of sweetened drinks. In addition, certain types of caloric sweeteners, such as high-fructose corn syrup, might, in and of themselves, contribute to increased weight gain due to their influence on lipogenesis, insulin secretion or leptin production (27).

When eating in restaurants, individuals tend to consume a large amount of food and they tend to choose high-energy foods. Both the frequency of fast food consumption and the amount of energy intake from fast foods are increasing due to a variety of factors: big portion sizes, palatable and cheap foods, [affordable prizes](#), the attractiveness of fast food and easy access to restaurants attractive for children and adolescents (28). There are no longitudinal studies on the direct relationship between fast food intake and the risk of overweight development in children.

Nowadays, the portion sizes of some food items (snacks, soft drinks, french fries, hamburgers, etc.) are on the increase and this is in parallel with the rise in the prevalence of obesity. It has been shown that children's energy intake increases when larger portions are offered (29). There are neither cross-sectional nor longitudinal studies that have found associations between food portion size and the risk of overweight development in children.

To date, with the exception of infants, longitudinal studies in children have not found clear causal associations between energy intake or diet composition and overweight development. Among formula or mixed-fed infants, not in [those](#) breastfed, increases in total energy and food intake showed an association with a risk of overweight at 3-5 years of age. Breastfeeding also seems to [be protective](#) and associated with a lower risk of overweight and obesity in later years.

Despite the fact that snacking, fast food consumption and big food portion sizes have been associated with non-healthy habits and excessive energy/fat intake, none of these factors have been significantly related to obesity in cross-sectional or longitudinal studies. Probably, a combination of all these factor, and other related ones could, at the end , be related with obesity [onset](#) in children and adolescents.

Effect of macronutrient distribution of dietary intake on childhood obesity

The different macronutrient distribution of the diet is important regarding the development of childhood and adolescents obesity (30). The recommended dietary macronutrient content in diet for children aged 4-18 are 25-35% of energy from fat, 10-30% from protein and 45-65% from carbohydrates according to the Institute of Medicine (31, 32). In the last years, consumption data from United States indicate that the percent of calories from fat has decreased (although total fat grams increased) and percent from carbohydrate has also increased (33, 34). Moreover, this rise in carbohydrate intake appears to be due to an increased consumption of refined grain products and soft drinks (35), whereas intakes of total fiber have decreased (36).

Most of the dietary fat in the Canadian children (as a proxy of Western population) comes from sandwiches, sweet baked goods, milk, salads with dressing, cheese, pasta, french fries, eggs and margarine (29). Fat intake is thought to be linked to an increase in food intake stimulation (hyperphagia) due to its low capacity of satiety, high palatability, energy density and poor metabolic regulation (37). Indeed, there are studies that show a positive association between the percentage of energy intake as dietary fat and markers of adiposity in children and adolescents (38), however in some longitudinal studies the results are negative (39). It must be taken into account that free-living studies are often biased by the food intake mis-reporting (40). In this context, a controlled trial showed that meal-induced thermogenesis in children is higher after a low-fat meal compared to a high-fat meal and postprandial fat storage is also higher (41). Moreover, low fat diets lead to long term weight loss and beneficial changes in lipids, blood glucose, glycaemic control, and blood pressure in children and adolescents (42).

In the last years, the type of dietary fat is receiving more attention regarding its association with obesity. Obese children consumed a higher amount of saturated fat compared to non-obese children (43) and saturated fat intake has been associated with greater body mass index (44). Furthermore, it has been shown that the polyunsaturated fatty acid intake results in a minor increase in body fat compared to monounsaturated and saturated fatty acids intake (45). Although energy density is almost the same, the effect of each type of fat on obesity requires further investigation given their different physiological effects (46).. Since in Western societies infants are exposed to high n-6, saturated and trans fatty acids and low n-3 fatty acids, this diet composition may

contribute to oxidative stress and heightened inflammatory responses in young children (47).

Since carbohydrates have significantly lower energy density compared to fat, it has been suggested that carbohydrate intake may be inversely related to obesity (46). Indeed, there are some cross-sectional and longitudinal studies that have associated lower intake of carbohydrates with obesity (48, 49). But few studies among children have been focused on types of carbohydrates and its relationship with obesity

The role of fiber could be important in childhood obesity, but only a small number of studies have specifically examined fiber intake in children. Some dietary surveys show that low consumption of fruit and vegetables among young people increases the energy density of the overall diet (50) and the available evidence suggests that consumption of fiber potentially could play a useful role in weight maintenance (51). Children usually have a suboptimal number of servings from fruit and vegetable groups (52), what represents that the intake of fiber, vitamins and minerals is below the recommended dietary allowances. Some social programs, like the National School Lunch Program (NSLP) (53) have had a positive impact on intakes of micronutrients such as vitamin A, B₁₂, B₆, riboflavin, niacin, calcium, phosphorus, magnesium and zinc (54). Programs focused on the study and improvement of children and adolescents nutrition are good tools. In this sense, in Spain a program of study and intervention, the EVASYON study, is being with obese adolescents.

Other factor concerning the diet composition related to carbohydrates metabolism is the glycemic index and the glycemic load. Glycemic index represents the relative rate of entry of glucose into the bloodstream compared to a reference carbohydrate, whereas glycemic load represents both the quality of the carbohydrate containing food and the quantity consumed (55). There are some studies that have associated the glycemic index and glycemic load with obesity in children (56, 57). Moreover, it has been shown that after a high glycemic index meal, children and adolescents had a greater voluntary energy intake than after low glycemic index meal (58). Design of a low fat diet can be consistent with low glycemic index. Such a diet provides the best chance for long term change to healthy eating habits, although palatability could be a problem (42).

Few studies have investigated the role of protein intake in childhood and adolescent obesity. There are reports about the association between high protein intake and a early adiposity rebound that has been related with childhood obesity (59). But

there are not available data to assess the association between obesity and protein intake in older children or adolescents.

Protein is a highly satiating macronutrient and some authors have suggested that low-carbohydrate/high protein diets could be a starting point for poorly motivated patients to lose weight (60). There are also some trials that have been focused on low-carbohydrate diets vs. energy-restricted low-fat diets (60, 30). The first trial of this type in children was reported by Pena et al. (61). They treated 104 children from 6 to 14 years old with an *ad libitum* ketogenic low carbohydrate (<20g/day) diet or with a balanced hypocaloric diet. After 8 weeks of dietetic treatment, in the group with the low carbohydrate diet the percentage of overweight subjects decreased more than in the hypocaloric group. In the study of Sondike et al. (62) they included 20 subjects in the group of low carbohydrate diet and 19 in the group of low-fat diet. Before 12 weeks of treatment, subjects with the low carbohydrate diet had lost more weight than subjects with the low fat diet. Other similar study, performed only with 19 subjects, but with one year follow-up period with hypocaloric balanced diet did not show differences in weight loss between the two groups after one year since the low carbohydrate diet (63).

It appears that in the short-term, subjects with low-carbohydrate diets have a higher decrease in BMI, but more research would be needed to obtain conclusions in long-term time period (60, 64). Moreover, some side effects, such as headache, constipation, halitosis, fatigue, and deterioration of lipid profile should be taken into account with this type of diets (42).

Dietary interventions are aimed to reduce the intake of high-fat foods, simple sugars, and sweetened beverages and at to increase the intake of low-calorie high-fiber foods such as fruits, vegetables, and whole grains (64). Some studies have performed intervention trials with balanced hypocaloric diets in children and adolescents. Those studies usually include a parallel moreover to increase physical activity, including behavioural therapy, to modify and reducing sedentary behaviour and cognitive therapy (65). A recently published meta-analysis found eight randomised controlled trials of intervention for children obesity, where a 'true' control arm was used and results were reported post intervention that included 268 subjects (66). Most of that studies used the traffic light diet (67) or calorie exchange programs and the pooled standardised mean difference of BMI after treatment was -1.82 , 95% CI $(-2.40$ to $-1.23)$.

For obese children aged 7 years or younger who have no secondary complications, the accepted standard practice is denoted to weight maintenance. Weight

loss is recommended for those older than 7 years with a BMI between the 85th percentile and 95th percentile who have a secondary complication of obesity and for those with BMI at or above the 95th percentile. The initial aim in children who have to reduce their weight is a rate of approximately 0.45 kg per month (68).

Other factors **may modify** weight loss by dieting are sex, age, initial body weight, race, genetics, regional fat deposition, lifestyle and family factors etc, which must be taken into account to explain the variability in the outcomes of different **treatment** with low-energy diets (30, 64, 69). Therefore, more research is needed about the impact of diets with different fuel substrates and food item on the characteristics of the weight-loss process.

Obesity treatment for obese adolescents

Prevention is a keystone to slow down, if not stop, the obesity epidemic, but also the treatment is an important part of the multilevel response needed. Although there is a growing awareness of the long-term health complications of obesity, yet many paediatricians do or can not offer effective treatment to obese adolescents in the absence of co-morbid conditions. Successful methods to treat paediatric overweight remain elusive, but together with previously discussed energy intake **reduction** a behaviour modification, and family involvement to encourage increased physical activity and a reduced sedentary activity are other assumed cornerstones of adolescent weight management and are being actively investigated. Successful behavioural programs are labour intensive, are not yet translated into versions that can be easily applied on the primary care level, and require intensive parental involvement.

Even though obesity is now viewed as a chronic disorder that requires continued treatment; very few controlled studies lasting more than a few weeks have examined the efficacy of treatment programmes in primary care centres, to reduce body weight and changes of habits and behaviour in overweight and obese children or adolescents. With the objective of developing a sustainable long-term multidisciplinary obesity treatment program adapted to Spanish primary care centres, the EVASYON (Development, implementation and evaluation of the efficacy of a treatment programme for adolescents with overweight and obesity: Integral education on nutrition and physical activity [Sp:

Desarrollo, aplicación y evaluación de la eficacia de un programa terapéutico para adolescentes con sobrepeso y obesidad: educación integral nutricional y de actividad física]) study was designed and is now assessed in 5 centers of paediatrics in the cities of Granada, Madrid, Pamplona, Santander and Zaragoza, and financed by the Spanish Ministry of Health.

The one year's treatment of obese adolescents in primary care setting has a multidisciplinary approach and includes nutritional and individual diet counselling, modification of diet and caloric content, increased physical activity and exercise, and active participation in appropriate activities, group therapy focused on changing behaviours, support and encouragement for making these changes and to follow treatment recommendations. Treatment goals are realistic, focused on modest reduction of intake, changes in eating habits, and the incorporation of a healthy active lifestyle. The clinical setting of this multidisciplinary programme includes the involvement, a part from the paediatricians, of nutritionists, qualified mental health professionals and physical activity and exercise specialists, following a standardized methodology and protocols established specially for this study.

Successful methods to treat paediatric overweight and obesity remain a difficult task, but we should not forget that not only weight reduction is the aim of any programme, but to change lifestyles and to reduce long-term risk factors associated with obesity.

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