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Review

# Early prevention of obesity

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## Abstract

Childhood obesity is the metabolic disorder with the highest prevalence in both children and adults. Urgency to treat and prevent childhood obesity is based on the clear evidence that obesity tends to track from childhood to adulthood, is associated to morbidity also in childhood and to long-term mortality. Early life, i.e., intrauterine life and the first two years, is a sensitive window for prevention. Anatomical and functional maturation of the hypothalamic structures devoted to regulating energy intake and expenditure and body size mainly occurs in the first 1,000 days of life. Therefore, factors affecting the foetal exposition to maternal metabolic environment and early postnatal nutrition are crucial in modulating the definition of the metabolic programming processes in the brain. Maternal diseases, mainly malnutrition for defect or excess, obesity and diabetes, placental disorders and dysfunctions, maternal use of alcohol and drugs, smoking, affect long term metabolic programming of the foetus with lifelong consequences. Similarly, early nutrition contributes to complete the long-term metabolic regulating framework initiated in the uterus. Breastfeeding, adequate weaning, attention to portion size and diet composition are potential tools for reducing the obesity risk later in childhood. Longitudinal randomized controlled studies are needed for exploring the efficacy of obesity prevention strategies initiated after conception.

## Keywords

Infant, obesity, nutrition, prevention.

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## Introduction

Childhood obesity is the most common metabolic disorder in children and adolescents. Other than its high prevalence, three are the main reasons for treating and preventing childhood obesity: i. persistency of childhood obesity into adulthood [1, 2]; ii. metabolic and non metabolic morbidity obesity associated [3, 4]; iii. higher mortality in adulthood [5]. Several scientific societies published guidelines for prevention and treatment of childhood obesity, based on available scientific evidence [6-9]. Nutrition and physical activity are the main tools of intervention. Recent evidence suggests that prevention should start early, from intrauterine life and infancy, when the sensitivity of the organism to metabolic long-term programming processes is high and the potential impact of the intervention may be considerable [10].

## Nutrition as a critical tool for prevention

Among the different areas of intervention, nutrition is the most relevant. Even though prevention is important throughout the entire lifetime, nutritional intervention is most promising in the first 1,000 days from conception, that is, during intrauterine life, and then from birth up to the first two years of life. Both mothers and pediatricians should pay particular attention to this stage of life. There is, in fact, an opportunity of intervention, particularly in diet-related issues, on processes affecting children's health in the long term. At this stage, hypothalamus, the control unit of the delicate hunger/satiety equilibrium, reaches anatomical and functional maturation. There is convincing evidence supporting the importance of ensuring adequate nutrient flow to the fetus, to avoid defects or excesses with potential repercussions not only in the developmental stage, but also in the entire existence (**Fig. 1**) [11, 12]. It has been demonstrated that the metabolic characteristics regulating nutrient metabolism and body composition are planned in the early stages of life. Scientific evidence confirms that, in addition to genetics, environmental conditions, particularly nutrition, play a crucial role. Pregnancy, breastfeeding and weaning constitute the most important phases of the first 1,000 days, in which nutrition may affect the growing process, with potential positive or negative impact also on future health.

## Pregnancy

In order to enhance opportunity of prevention during this important stage, attention should be paid to the pregnant woman's nutritional habits, sport activity and general lifestyle, treating early diabetes or nutritional excesses or deficiencies, providing information and education on appropriate nutrition. Obesity and diabetes in pregnancy are growing problems in industrialized countries [13]. A recent study showed that infants' birth weight of women with type 2 diabetes and excessive gestational weight gain was almost 0.5 kg higher than in women with type 2 diabetes and non-excessive weight gain [14]. A high birth weight is a risk factor for obesity development later in life [15, 16].

Consistent evidence is available also on the relationship between exposition to maternal diabetes during intrauterine life and glucose intolerance in adulthood. In particular, offspring of women with gestational diabetes mellitus (n = 167) or type 1 diabetes (n = 153) and offspring of women with risk factors for gestational diabetes mellitus but normoglycemia during pregnancy (n = 139) and offspring from the background population (n = 128) were followed up at the age of 18-27 years [17]. Both groups of offspring exposed during pregnancy to either maternal gestational diabetes or type 1 diabetes had reduced insulin sensitivity compared to offspring from the background population. No significant difference in absolute measures of insulin release was found. However, the disposition index was significantly reduced in both the diabetes-exposed groups. Therefore, offspring born to women with diabetes during pregnancy had reduced insulin sensitivity and impaired pancreatic β-cell function in adulthood, factors contributing to the increased risk of glucose intolerance in these individuals.

Recent data obtained in a mouse model of maternal diet-induced obesity showed that offspring from obese mothers develop pathologic cardiac hypertrophy, severe systolic and diastolic

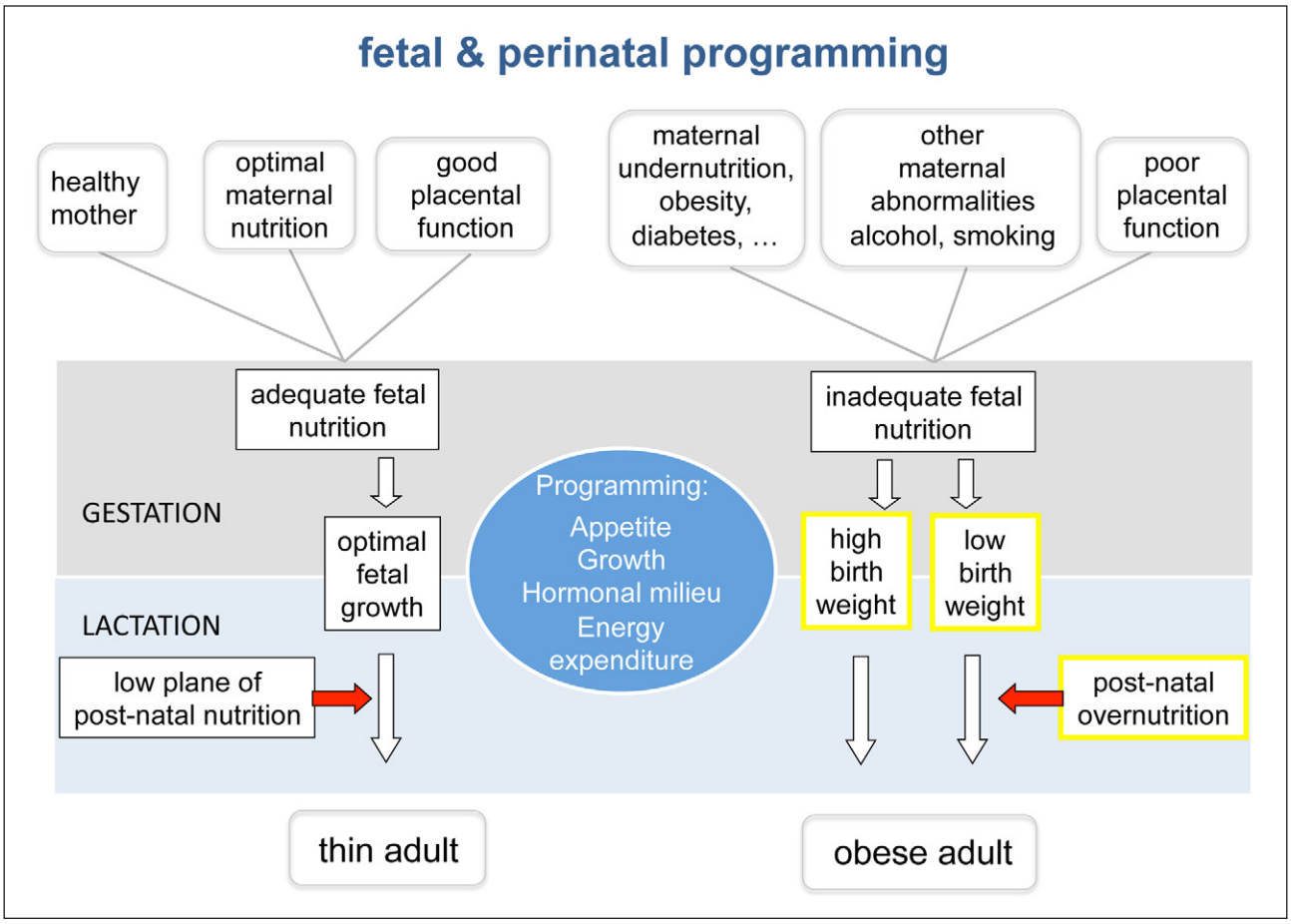


**Figure 1.** Developmental programming of adult obesity (modified from: Cripps et al., 2005 [12]).

dysfunction and cardiac sympathetic dominance in young adulthood [18]. Interestingly, offspring was eating a healthy low-fat diet and had not changed in corresponding body weight. These findings support the hypothesis of a causal link relating intrauterine exposition to maternal obesity with premature death from cardiovascular disease in her offspring in humans.

## First two years of life

After birth, early pediatric intervention is essential and should continue through simple but important actions: breastfeeding promotion, newborn's weight and length monitoring, balanced weaning, and limiting the use of cow's milk before the 12$^{th}$ month of life.

### *Breastfeeding*

Numerous observational studies have described associations between breastfeeding and lower rates of later obesity [19, 20]. However, these may be a consequence of confounding by factors such as socioeconomic class and maternal BMI [21, 22]. Nevertheless, although a definitive evidence of the long-term protective effect of breastfeeding on the development of obesity is still not available, all the important benefits associated with this practice strongly support the need of promoting prolonged breastfeeding in the population [23, 24].

### *Formula feeding*

High protein intake was associated with more rapid weight gain during infancy [25]. Formula milk has a higher protein content than human milk. The results of a recent European multicenter, double-blind, randomized clinical trial showed that infants fed with a higher protein content formula in the first year of life had a higher BMI than infants fed with a lower protein content formula at 6 years of age (both formulas within recommended protein amounts) [26]. This finding suggests the importance of avoiding infant foods that provide excessive protein intakes, which may contribute to increase

the risk of obesity at school age. Accordingly, cow milk intake, which has a protein content more than threefold than that of human milk, should be avoided till the age of 12 months in all infants.

*Growth monitoring*

Rapid, early weight gain has been consistently shown to be a risk factor for later obesity [27, 28]. In particular, an increase of 1 SD in weight z-score in the first year of life has been associated with a 2-fold risk of childhood obesity and a 23% higher risk of obesity in adulthood [29]. This evidence strongly supports the recommendation to monitor length and weight of infants and toddlers regularly to identify inconsistency between length and weight growth velocity and to perform adequate intervention.

*Diet composition*

Human milk has a high fat content (≈ 55% of total energy) and a moderate carbohydrate content (≈ 38% of total energy). This composition fully satisfy infant needs until the age of 6 months. Afterwards, fat intake should gradually decrease until 35% of total energy at two years and carbohydrate intake should gradually increase until 50-55% of total energy at two years [30]. Progressive reduction of the speed of body growth from birth to two years and changes in body composition, i.e., increase of skeletal and cerebral mass, and increase of physical activity contribute to explain the variation of nutrient requirements. Both factors promote an increase of the carbohydrate requirement, i.e., the main fuel oxidized in the brain and skeletal muscle. However, misleading beliefs on nutrient intake requirements in toddlers is common. In particular, most of the mothers (87%) believe that a low-fat intake is very important in the second year of life, based on the hypothesis that restricting fat is healthier [31]. On the contrary, an adequate fat intake is required also in the second year of life, due to the high requirement especially for cell membrane synthesis in the central nervous system.

Therefore, supervision of children's menus is essential to ensure access to every food group and, gradually, to the greatest variety, and at the same time guaranteeing adequate nutrient composition. Equally relevant is the use of natural flavors in food preparation, avoiding salt and sugar. This promotes the natural development of children's taste perception. Early-life experiences with healthy tastes and flavors may promote healthy eating, with a potential impact in addressing the many chronic illnesses associated with poor food choice [32].

*Portion size*

Large portion sizes have been associated with large energy intake, which may contribute to the development of overweight and obesity [33]. A recent study conducted in Denmark reported a secular trend in mean portion size [34]. Energy content per portion increased significantly by 21% over the past 100 years in the analyzed recipes. The mean portion size in calories from a composed homemade meal increased by 77%, 27% from meat, 148% from starchy products, 37% from vegetables and 47% from sauce, throughout the years. The same trend is likely to be found in other Western countries.

The food serving made by parents is another contributing factor to overeating. In particular, the amounts of food that parents served themselves have been significantly associated with the amounts that they served to their preschool children [35]. Moreover, the amounts served to children were strongly associated with the amount that consumed by children. Therefore, factors unrelated to the child (such as the amount a parent serves himself or herself) are important predictors of children's consumption.

Finally, plate size plays a role in the overeating process. Using adult-size dishware, children served more energy (mean = 90.1 kcal) and this promoted energy intake indirectly, where every additional calorie served resulted in a 0.43-kcal increase in total energy intakes at lunch [36].

## Pollution as a metabolic risk factor

Chemicals such as dioxins, polychlorinated biphenyls (PCBs), and organ chlorine pesticides (OPs), that are resistant to biodegradation and, thus, bio accumulate in living organisms, have been included in the group of persistent organic pollutants (POPs). POPs have been used extensively in agricultural, industrial, and manufacturing processes. Potential toxicity of POPs induced their strict regulation by the Stockholm Convention since 2004. Nevertheless, POPs are still omnipresent in the environment, especially in the food chain [37, 38]. Recently, the presence of dioxins, PCBs, and OPs in rodent diet was found to accelerate the development of insulin resistance, glucose intolerance, low-grade inflammation, and visceral obesity in both mice and rats [39, 40]. The impact

of early exposition to POPs on the development of obesity, diabetes and other metabolic disorders in humans is object of investigation.

Children have a higher sensitivity to POPs and exposure to potentially toxic substances in proportion to their weight comparing to adults: 110 g food/kg/day at 6 months compared to 30 g/kg/day to 15 years. More food can also mean increased exposure to toxic substances.

Reduction of exposition to POPs in early ages is highly advisable. The tendency to drop out specific foods for children, subjected to very strict regulation for safety, in favor of packaged foods destined to adults need particular attention, and some precaution in preparing these foods is necessary. The American Academy of Pediatrics has recently published some useful recommendations for reducing pesticides exposition by food ingestion [41]. In particular, consumption of organic produce, washing and peeling off outer layers of vegetables, removing peels from fruit and vegetables and trimming fat from meat and fat and skin from poultry and fish reduce residues of persistent pesticides that tend to accumulate in fat.

## Conclusions

Pediatricians have an active and fundamental role in helping mothers build clear, simple, and effective nutritional paths. The child is not a "small adult" and needs targeted and personalized diet changes especially during the first two years of life. Breastfeeding and adequate and equilibrated weaning is crucial, as well as portion size and diet composition. In particular, the difficulty to maintain protein intake within recommendations imposes calculating diet composition and making changes to comply with them. Moreover, a progressive and slow change of the lipid/carbohydrate ratio between the sixth and the second year of life is recommended. The efficacy of childhood obesity prevention strategies initiated early after conception need to be explored by randomized controlled longitudinal studies.

Nutrition in the first 1,000 days is a testing ground for the pediatrician. Explaining effectively the role of nutrition to parents in a society affected by so rapid socio-cultural and economic changes is not an easy task. It is therefore essential to transfer to families nutritional knowledge based on convincing evidence. The future of children, adults of tomorrow, is a goal deserving the highest commitment.

## Declaration of interest

The Author declares that there is no conflict of interest.

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