

## Review Article

# Adolescent Nutrition

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Adolescence is characterized as a phase of great physical, emotional and social changes, through complex, continuous and non-uniform events, which promote the necessary physiological changes to transform the individual into an adult. For this, the human being suffers multiple influences from the environment that, associated with their genetic potential, will trigger processes of accelerated growth, changes in body composition and sexual maturation. During adolescence, a pubertal outbreak occurs, responsible for increasing weight, height and changes in body composition, adding bone tissue, fat and muscle mass. Due to all the physical changes that occur at this stage of life, adolescence is a period in which individuals have specific nutritional needs that must be observed so that hormonal stimuli and interaction with the environment can play a fundamental role in modulating growth and development. This article presents some characteristics involved in the adolescent's nutrition process, seeking to highlight aspects related to energy intake, macronutrients and micronutrients. In addition, some characteristics related to eating behavior are discussed and aspects of encouraging the consumption of healthy foods are discussed, with support from the family, the school and the whole society.

**Keywords:** Adolescence; Nutrition; Adolescent nutrition; Eating behavior

## Introduction

Adolescence, from a chronological point of view, comprises the second decade of life and is characterized as a phase of great physical, emotional, and social changes that the individual goes through, evolving from childhood to adulthood. For this, the human being suffers multiple influences from the environment, which acting on his genetic potential will trigger the processes of accelerating growth, modification of body composition and sexual maturation, culminating in the physical and emotional structuring of an organism that will reach its full productive capacity [1].

The process of growth and development of the human being is a complex, continuous and non-uniform event, which promotes the necessary physiological changes to transform the individual into an adult being. Among the stages of growth with increased speed, adolescence stands out as the second fastest period, when the pubertal spurt occurs, which is responsible for increasing weight, height and changes in body composition, adding to bone tissue, fat and muscle mass [2,3]. Due to all the physical changes that occur during this stage of life, adolescence is a period in which individuals have specific nutritional needs that must be observed so that hormonal stimuli and interaction with the environment can play a fundamental role in modulating growth and development [4].

### Nutritional needs

Individual variability, anabolic increase, and adolescent maturation determine that their nutritional needs vary according to the stages of pubertal development. Hormonal, genetics and environmental factors continuously interact to modify the growth. Regarding weight, males, by testosterone action, have a greater amount of muscle mass, while greater fat deposition is seen among girls, due to the effects of estrogen and progesterone [5].

### Energy

In addition to the energy required for basic life-sustaining processes (basal metabolism), caloric requirements are high and determined by physical activity, growth and accumulation of lean tissue [6]. Energy needs aim to meet all demands and vary according to sex, age, height, level of physical activity, climate and other ecological factors, with the period of greatest caloric intake coinciding with the peak of maximum growth speed. The caloric requirement of adolescent males is higher than that of females, owing to greater increases in height, weight, and lean body mass. Boys' height velocity begins one-two years after girls and takes more time [7]. Up to 13 years of age, 2100 Kcal/day is required for females and 2300 Kcal/day for males; from the age of 14, these needs increase to 2400 Kcal/day and 3100 Kcal/day, respectively. In special, during the puberty spurt occurs a 12% increase in basal metabolic rate and 18% increase in total energy expenditure, accounted for largely by the increase in fat-free mass. The energy balance of an adequate diet must be distributed in at least 50% of the total calorie from carbohydrate, 35% from fat and 15% of protein [7,8].

### Protein

Protein requirements are necessary to maintain the body mass and to obtain adequate pubertal spurt and growth. A healthy diet should contain 10% to 30% of calories based on protein intake, of which 2/3 should be of animal origin and 1/3 of high biological value [9]. While for females the daily amounts vary little, between 44 to 46 grams/day, for males between 46 and 59 gram/day are necessary for a complete corporal satisfaction. It is important to check the relationship between the amount of protein and the total energy ingested, because when energy is insufficient, the protein can be used as an energy substrate, reducing its availability for primary functions [10].

## Carbohydrate

Carbohydrates must contribute with approximately 50% of the total energy and be provided by naturally occurring sugars (preferably amylose and amylopectin) and added sugar as mono and disaccharides. It is important to consider the need to ingest complex carbohydrates, which also constitute an important source of fiber. Refined sugars, however, should be limited to less than 8 to 10% of total energy because of their relationship to excessive weight gain [6,9].

## Fat

Fat in the diet is essential for absorption of fat-soluble vitamins and production of cholesterol and sex hormones. It should also be considered that atherosclerotic lesions in the aorta and coronary arteries can begin to appear early and are positively associated with total elevation and low-density lipoprotein cholesterol [11]. Therefore, in addition to the energy needs supplied by fats, the quality of this nutrient must also be observed. About 35% and no less than 20% of calories must be supplied by fat distributing in 7% by saturated fats, 10% to 15% by monounsaturated fat, 13% by polyunsaturated fats, less than 1% from saturated trans fat and no more than 300 mg/day of cholesterol [9]. The diet must also meet the needs for essential fatty acids (linoleic and linolenic) from plant sources, such as nuts, soybean oils, corn, canola, cotton and sesame.

## Fiber

Dietary fiber is a vegetable food residue, resistant to hydrolysis by digestive enzymes, which can reduce cholesterol absorption and produce short-chain fatty acids, causing satiety and increasing stool volume. The beneficial effects of the consumption of fruits and vegetables are related to the promotion of health and prevention of diseases, providing food with a reduction in the total energy levels, energy density, and the supply of vitamins and minerals. One of the factors that interfere with their consumption by adolescents is the low palatability. It is desirable that the diet is composed by whole foods with high fiber content from vegetables, legumes and fruits. While for adolescents up to 13 years of age, about 30 grams of fiber daily is sufficient, after 14 years this amount should be increased to 38 grams/day [6,12].

## Calcium

The requirements of calcium to bone mineralization are the highest in adolescence compared to other life stages. Calcium is the most abundant mineral in the body and, as is not produced endogenously to be ingested daily, to perform two principal functions: It is an integral part of the bone structure (99% of its concentration is found in the bones where supports the growth in length and width), and acts as a reservoir to be released into organic fluids, presenting great metabolic interaction with others elements such as phosphorus and vitamin D. Due to hormonal influences, during puberty males acquire more bone mass than females [12].

Mineral deposition of calcium in bones reaches its peak during the adolescent years and the daily needs are 1300 mg that must be obtained from foods such as milk and dairy products, cabbage and beans. Heavy consume of carbonated soft drinks, caffeine, phytates, oxalates, tannins, alcohol abuse, and use of contraceptive pills can have a significant impact on the rate of bone deposition [12,13].

## Iron

Iron needs are determined by the demand for tissue development, increased erythrocyte mass and hemoglobin concentration, and replacement of losses to urine, feces, sweat and menstruation. It is a fundamental element for the expansion of blood volume, for the increase of muscle mass (by the increase in myoglobin) and constitutes an important part of several enzymes [14]. The bioavailability of iron depends on some conditions related to the food source and the digestive process. Heme iron is present in animal foods, such as meat, chicken and fish, and is easily absorbed by the intestinal mucosa without the interference of chemical and/or dietary factors. Its absorption is facilitated by the presence of vitamin C and, but its absorption may be reduced by oxalate, phytate, calcium and phenolic compounds. Up to 18 years old, both boys and girls need 18 mg/day of iron. From 19 years old onwards boys need 10 mg/day, while girls continue to require higher amounts due to menstrual losses. Intestinal loss and shedding of skin and other epithelial cells are also pathways of iron loss [15]. Iron deficiency and iron deficiency anemia has been shown to cause negative impacts to the organism like as decrease learning and work capacity, increase fatigue and growth retardation [16].

## Zinc

Zinc is the second micronutrient with the highest concentrations in the human organism being considered a fundamental element for the processes of growth, differentiation and cell division, synthesis of DNA, RNA transcription, sexual maturation and growth of connective tissue, among many others. A normal and balanced diet can offer between 10 and 15 mg/day of zinc. Among the richest foods in this micronutrient, fish, meat, poultry, milk and dairy products stand out that can offer about 80% of that total. Bioavailability must also be considered zinc in these food sources, which can vary from 10% to 30%, depending on different compositions of the diet. Daily requirements vary between 10 and 15 mg [17-19].

## Vitamins

Vitamins are involved in many of enzymatic activities associated with the growth process, metabolism of nucleic acids, DNA synthesis, cell replication and the effectiveness of the body's metabolic process [5,20]. Among the main vitamins, usually necessary in small concentrations, some characteristics can be highlighted:

- Vitamin A: foods of animal origin provide preformed vitamin A in active form, while vegetables provide pro-vitamin A in the form of carotene;
- Vitamin D: increased needs in periods of accelerated growth interacting with calcium and phosphorus; exposure to sun light provides some of the vitamin D through photo conversion.
- Folate: is essential for replication and translation of DNA, cell division and protein synthesis.
- Vitamin C: has antioxidant action; is fundamental for collagen production, blood vessel integrity, and the immune response; smoking and use of oral contraceptives on a large scale may reduce serum concentration;
- Vitamin B12: of animal origin, it has effects on the maturation of red blood cells and performs multiple functions in the

metabolic pathways necessary for the central and peripheral nervous system.

**Water**

As the largest component of the human body, water is essential for various functions such as promoting chemical reactions, regulating temperature and excreting harmful substances, among others. At least two liters daily of fluids should be consumed throughout the day, preferably water, avoiding the consumption of sugary drinks. This amount must be increased according to climatic conditions, type of diet and amounts lost in physical activities [6,21].

**Alternative diets**

The limitation of the consumption of animal products and their derivatives (due to moral, religious, ethics or environmental viewpoints) seems to be one of the common choices for those who wish to improve their health status. However, when this occurs during adolescence, it is necessary to know some details that can compromise the individual’s health [22,23]. Among the most adopted alternative diets vegetarianism stands out, although is considered restrictive and those who practice it must be accompanied by an experienced professional [24]. However, the American Dietetic Association considers that well-planned vegetarian diet can satisfy the nutritional needs [25].

The vegetarian diet contains less calories and high dietary fiber which helps in intestinal transit but can reduce the absorption of some micronutrients such as iron, zinc, magnesium, calcium, and some amino acids [26]. While smaller amounts of saturated fat and cholesterol can be considered health benefits, nutritional risks include lack of some essential fatty acids (mainly omega-3 family), vitamin B12, vitamin D, iodine, calcium, and iron [27-29]. Such nutritional inadequacies can be aggravated due to the high demand and the lack of food organization typical of adolescents [30].

The different types of vegetarian diet are: a) lacto vegetarian (eat dairy products; b) egg vegetarian (eat egg); pescos vegetarian (eat fish); lacto egg vegetarian (eat dairy products and egg); vegan (the most restrictive and the one most likely to result in nutrient deficits since it excludes all animal products). Vegetarian adolescents may be at risk if nutrients are found in small amounts and are interfered with absorption due to the high content of inhibitory substances in these foods (phytates, and tannins) [22,24,31].

**Pregnancy and lactation**

Pregnancy and lactation are physiological conditions that can interfere with nutrient stocks and cause a decrease of growth in undernourished adolescent. Since their bodies are not physically ready for pregnancy adequate supply of nutrients is a high priority to ensure growth and additional demands caused by a competition for nutrients with the fetus [32,33]. Therefore, pregnant adolescents need early access to prenatal care to receive nutrition counseling and treatment for condition that may impair their pregnancy outcome [34].

World Health Organization recommended that during pregnancy women increase their energy intake by 85 Kcal/day in the first trimester, 285 Kcal/day in the second trimester, and 475 Kcal/day in the third trimester, which must be maintained throughout the lactation period. 1,1 g/kg/day of protein is necessary for tissue

**Appendix:** Distribution of nutritional needs and daily intake recommendations during adolescence (Modified from IOM).

	Male		Female	
	9-13	14-19	9-13	14-19
Age (years)	9-13	14-19	9-13	14-19
Energy (kcal)	2280	3150	2070	2370
Carbohydrate (g)	130	130	130	130
Protein (g)	34	52	34	46
Linoleic acid (g)	12	16	10	11
Linolenic acid (g)	1,2	1,6	1,0	1,1
Calcium (mg)	1300	1300	1300	1300
Iron (mg)	8	11	8	15
Zinc (mg)	8	11	8	9
Iodine (µg)	120	150	120	150
Copper (µg)	700	890	700	890
Magnesium (mg)	240	410	240	360
Fluorine (mg)	2	3	2	3
Folate (µg)	300	400	300	400
Vitamin A (µg)	600	900	600	700
Vitamin C (mg)	45	75	45	65
Vitamin D (µg)	5	5	5	5
Tiamine (mg)	0,9	1,2	0,9	1,0
Riboflavine (mg)	0,9	1,3	0,9	1,0
Niacine (mg)	12	16	12	14
Vitamin B6 (mg)	1,0	1,3	1,0	1,2
Sodium (g)	1,5	1,5	1,5	1,5
Potassium (g)	4,5	4,7	4,5	4,7
Chlorine (g)	2,3	2,3	2,3	2,3
Water (L)	2,4	3,3	2,1	2,3

formation for the fetus, placenta and maternal issues; fat should represent 30% of overall energy, and an increase in carbohydrate intake of 45g/day is recommended [34]. Special attention should be paid to the intake of iron, iodine, calcium and vitamins, especially folic acid, which requires adequate supplementation [35,36].

**Physical activity**

In addition to the minimum necessary for basal metabolism and growth, the physical activity developed by the adolescent also requires adequate amounts of energy for this demand. A typical mixed diet can offer the amounts of energy and macronutrients needed to maintain good health and recreational physical activity. Eventually an additional amount of carbohydrates can be offered in order to increase the energy immediately consumed and favor the water supply in the muscles [11] because hypohydration leads to fatigue, increased temperature and limits physical capacity. Indeed, a good hydration is always important, as well as the environmental and climatic conditions must be checked, so that physical activities are developed with intensity and duration that do not overload the organism [21].

**Characteristics of adolescent feeding [37-38]**

Adolescents are in a transition period when they gradually make

their own decisions about food and eating habits. Unfortunately, studies have found that they fail to meet dietary recommendations for overall status and for specific nutrient intakes [39,40]. They usually prefer fast food because are available almost all the time, is a place that allows socializing with peers, palatable, identified with young consumers, and are inexpensive [41]. However, this type of feeding leads to an excessive consume of low nutritional nutrient dense food, inappropriate portion sizes, great consume of salt, colas and sweet beverages. Some of the main characteristics related to adolescent nutritional habits are:

- Skipping meals (breakfast and/or dinner): the omission of breakfast can affect school performance;
- Do not obey meal times: conflicting lifestyle with family habits;
- Long breaks between meals;
- Take meals away from home;
- Replaces meals for snacks and sweets;

### Factors that influence adolescent eating

While nutrition is influenced by the evolutionary aspects of development, food choice is influenced by availability, convenience, conservation, distribution and time, rather than food value, and some several interrelated factors, of a different nature, which can be classified as [20,42-44]:

1. Immediate characteristic of the adolescent who wants to eat to satisfy hunger;
2. Family habits with their values and behaviors acquired over generations;
3. School: through the transmission of knowledge and availability of food purchased on site;
4. Work: restricted hours and the need to eat outside the home;
5. Peers: who set standards specific to the age group;
6. Self-image: that can stimulate inappropriate dietary restrictions (it is common for adolescents to be unhappy about their changing bodies);
7. Media: food and beer companies target adolescents (dieting is more common among female because they are more dissatisfied with their weight);
8. Geophysical aspects: urban or rural dwelling, cost of meals, access to convenience foods, fast foods, vending machine foods;
9. Ethnic and religious beliefs, attitudes and practices

### Conclusion

Evidences show that many adolescents do not follow a diet which meets their dietary guidelines and suboptimal food and nutrient intake during adolescence increases the risk of nutritional deficiencies that compromise growth and development [6,12]. Healthy eating must meet all the needs of the body, be accessible, varied, balanced, safe and respect the cultural customs of individuals providing, in addition

to physical satisfaction, the emotional well-being of the individual.

In addition to the physical characteristics of the age group, the adolescent is considered an individual with nutritional vulnerability due to excessive consumption of added sugars, sodium, total saturated fatty acids, cholesterol, total fat, and trans fatty acids, combined with an inadequate intake of acid folic, vitamins A, C, D, calcium and zinc [12]. This inadequate diet contributes to several adverse health outcomes already in adolescence and increase risk in the future of non-communicable diseases such as diabetes, obesity, hypertension and cardiovascular diseases [45]. Eating habits acquired in early adolescence are often life-long and have a major impact on future life.

Adolescents are also future parents and therefore good eating habits acquired early can be passed on to the next generation [46]. Successfully meeting the challenges of adolescent nutrition requires collaboration among parents, teachers and other school personnel, key community members, dietitians, adolescent health care providers, researchers, policymakers, and adolescents themselves [47].

Adolescents are exposed to a great amount of nutrition information from various sources as traditional print media, newspaper, magazines, websites, blogs, social media platforms, television, and from social interaction with family and peers [48-50]. Education, health promotion, behavioral and psychological counseling could be implemented either at the individual level or combined with family/parent support in order to offer good living conditions to adolescents. The ultimate goal of all these actions should be to promote the consumption of a varied diet that includes adequate portions of each of the main food groups.

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