Contact Details

Barilla Center for Food & Nutrition
Via Mantova, 166
43122 Parma ITALY
info@barillacfn.com
www.barillacfn.com

Fondazione Barilla
il tuo cibo, la tua terra

Scientific partner

The European House Ambrosetti

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Healthy growth and nutrition in children

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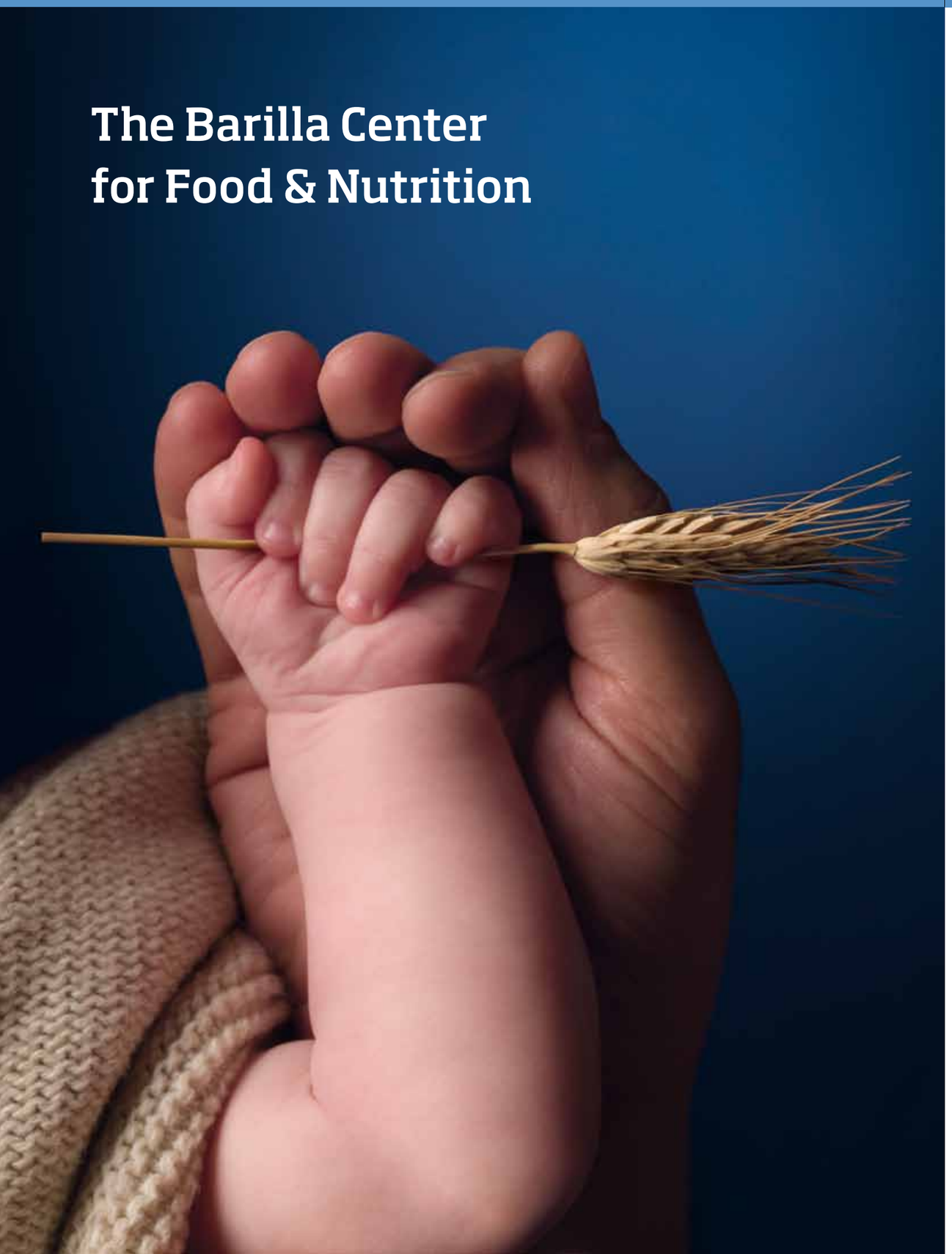
The Barilla Center for Food & Nutrition



The ***Barilla Center for Food & Nutrition*** is a think tank with a multi-disciplinary approach whose goal is to gather the most authoritative thinking on an international level regarding issues linked to the world of food and nutrition.

Its areas of study include *culture*, the *environment*, *health* and the *economy*, and, within these areas, it intends proposing solutions to take on the food challenges to be faced over the coming years.

The Barilla Center for Food & Nutrition, presided over by *Guido Barilla*, enjoys the support of an *Advisory Board*, a body which oversees foundation work through identifying the themes of interest, developing special and scientifically-valid content and offering recommendations and proposals.

The members of the Advisory Board are:

- *Barbara Buchner* (Director of the Climate Policy Initiative in Venice);
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In the preparation of this document, the Barilla Center for Food & Nutrition was privileged to have the collaboration of Prof. *Claudio Maffeis*, Università degli Studi di Verona.

The operational aspects of the *Barilla Center for Food & Nutrition* are the responsibility of *Valerio De Molli* (*Managing Partner*, The European House-Ambrosetti) and the *The European House-Ambrosetti Working Group*.

To-date, the Barilla Center for Food & Nutrition has published the following research studies:

- Water Management - March 2009;
- Climate Change, Agriculture and Diet - June 2009;
- Nutrition and Health - September 2009;
- Food Security - November 2009;
- Culture and Food - November 2009.

Analysis, commentary, proposals and, more generally, the entire content of the documents prepared by BCFN are available for consultation on the website, www.barillacfn.com.

Executive summary

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Malnutrition causes 53% of the 9.7 million deaths recorded in children under five years of age in developing countries. In these countries, approximately 148 million children in this age bracket are underweight due to an acute or chronic shortage of food.
This means that approx. 14% of those who suffer from hunger are children.

Acquiring and maintaining nutritional and exercise habits in line with changed social-environmental needs is an absolute must for the well-being of present and future generations.

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In Western countries, a large number of adult deaths is connected to problems deriving from **over-eating** and **poor eating habits**. In fact, the way in which we eat has a significant influence on the appearance of certain chronic pathologies–such as **obesity**, **type 2 diabetes**, **cardiovascular disease** and some types of **tumors**. All Western countries are experiencing exponential growth in the phenomenon of childhood overweight and obesity. According to data gathered by the international Obesity TaskForce,[1] **school-age overweight and obese children number 155 million worldwide**, equivalent to one out of ten. In **Italy**, overall, it is estimated that **more than 1,100,000 children** between six and eleven years of age have problems of obesity and overweight: more than one child in three.

It is essential, starting in childhood, to pay attention to adopting correct food habits and physically active life styles.

Given this, it is essential, **starting in childhood**, to pay attention to adopting **correct food** habits in terms of food preferences, dietary composition, how consumption levels are distributed throughout the day, portion size, ways foods are consumed and physically active life styles.

Nutrition and health in pre-school- and school-age children

During early childhood – characterized by rapid growth – it would seem very necessary that children be provided with **an adequate amount of energy**. In particular, the **macronutrients** contained in foods that can provide children with energy are **fats**, **carbohydrates** and **proteins**.

Proteins are essential for human cells. Excellent sources of high-quality proteins are **animal liver**, **meat**, **fish**, **cheese**, **milk** and **eggs** and some products of vegetable-origin, such as products derived from **soybeans**, **green beans** and **legumes**. **Products derived from wheat** also constitute a source of protein, but the majority of vegetables and fruits contain only a limited amount.

The second macronutrient essential for guaranteeing a correct and balanced energy level for children is that of **fats**. Fats consumed in the diet represent for children a **source of energy** and **essential fatty acids**. **Structural fats** are an essential part of the cell membrane, neural fabric and overall cellular structure, while **stored fats**–present especially in adipose tissue, primarily composed of triglycerides–provide a long-term energy reserve for the body.

Carbohydrates are the third and most important source of energy (in terms of quantity) for the body. Carbohydrates (sugars, starches and fiber) provide **energy to all tissues in the human body, especially the brain and red blood cells which normally utilize glucose as the "fuel" for cell activity.**

Alongside the main macronutrients, other essential elements in a proper diet for pre-school- and school-age children are **vitamins** and **minerals**. In small children, an adequate supply of **vitamin A** is necessary for correct development of vision, to guarantee the integrity of epithelial tissue and development of tissue differentiation. The principal sources of vitamin A are: **liver**, **dairy products**, **eggs**, **fish**, **margarine** and certain types of **fruit and vegetables** (for example, carrots and yellow/orange colored fruit). Like vitamin A, **B vitamins** play a fundamental role in the growth of children, as well as their correct sustenance and development. **Vitamin C** is key to optimum **functioning of the immune system** and for **collagen synthesis**. In addition, vitamin C contains **antioxidant properties** and plays a significant support role in the process of **iron absorption**. **Vitamin D** plays an essential role in **metabolizing calcium** (stimulating its absorption in the intestine), **muscle functioning**, **cell proliferation and maturation** and correct **functioning of the immune system**. Other elements essential in the diet of pre-school- and school-age children are **minerals**, specifically **iron**, **calcium**, **magnesium**, **phosphorus**, **sodium**, **zinc** and **iodine**.

1 *Source: IASO - International Association for the Study of Obesity; IOFT - International Obesity TaskForce*

Nutrition and health in adolescents

In adolescence, **somatic growth** is accompanied by rapid **psychological and behavioral development** which leads the adolescent to feel a progressively more intense need for independence and freedom; this also has a significant impact on eating habits. The major **physical changes** tied to rapid growth and modifications caused by **puberty** are accompanied by both a quantitative and qualitative increase in nutritional needs (carbohydrates, proteins, fats), vitamins, minerals, fiber and water.

In adolescence, somatic growth is accompanied by rapid psychological and behavioral development.

The most common deficiencies in nutrients at this age are those of **iron** and **calcium**. Anemia caused by iron deficiency is one of the most common diseases associated with food-related deficits.[2]
In adolescence, therefore, it is important that there be an increase in consumption of iron-rich foods, such as **lean meat** and **fish**, **legumes**, dark green **vegetables**, **walnuts**

Greg Dale/National Geographic Image Collection

and iron-enriched **grains**. Calcium also has an essential function in the rapidly-growing adolescent body because it is part of the composition of bone and teeth. Therefore, it is important to eat foods rich in calcium, not only for boys, but especially, for girls who in later years with the onset of menopause will be at greater risk of osteoporosis.

In addition to a healthy and correct diet, the health of adolescents is also associated with physical movement. **Motor activity** contributes to burning calories, releasing tension and stress, and improving mood and psychological well-being. Regular physical activity and sports significantly benefit the cardiovascular and skeletal system, as well as metabolism. Regular motor activity fosters the maintenance of proper body weight and fitness, makes adolescents stronger and accustoms them to adopting a lifestyle which will make them healthier in the years to come.

Motor activity contributes to burning calories, releasing tension and stress, and improving mood and psychological well-being.

Dietary guidelines for children and adolescents

In terms of how **meals** are divided over the course of the day, it should be noted that nutritionists recommend that children should eat **five** times per day.

William T. Douthitt/National Geographic Image Collection

A **recommended weekly breakdown** could be:

- **grains** (bread and pasta): every day;
- **fruit and vegetables**: every day;
- **milk and dairy products**: every day;
- **meat**: 2-3 times per week;
- **fish**: at least three times per week;
- **cheese**: twice a week;
- **eggs**: once or twice a week;
- **legumes**: at least twice a week.

In addition to strictly nutritionally-related recommendations, it should also be noted that regular physical activity (principally out-of-doors) is considered one of the fundamental factors in the health of children and adolescents (as this also has important positive spin-offs in terms of reducing risks connected with the onset of principal chronic diseases in later years, including as an adult).

One of the fundamental conditions of a healthy diet is variety. A **varied diet** will easily provide the nutrients adolescents and children require for growth.

Nutritionists recommend that children should eat five times per day.

Briefly, the guidelines to be followed in adopting eating habits and a lifestyle which promote healthy growth in adolescents are:

- **adopt a healthy, balanced diet**, which, through alternating on a daily basis all primary foods, provides all the nutrients and micronutrients (calcium, iron, vitamins, etc.) required by adolescents;
- **avoid excessive calorie intake** by avoiding consumption of high-calorie foods or those rich in fats;
- **divide nutrients in a balanced way throughout the day** to assure proper equilibrium between animal and vegetable proteins which should be 1, between simple and complex sugars (through consumption of fewer sweets, more bread, potatoes, pasta or rice), and between animal and vegetable fats (using less lard and butter and more olive oil);
- **reduce added salt to a minimum** in order to lower risk factors of developing high blood pressure, especially in adult years;
- **divide food consumption into 5 periods during the day**–breakfast, mid-morning snack, lunch, afternoon snack and supper;
- **avoid consuming food outside the five moments of the day identified above**;
- **engage in physical activity** for at least one hour per day, both as sports activity and recreation;
- **reduce sedentary activity as much as possible**, especially that spent in front of the television or computer screen.

RECOMMENDATIONS

1. Promote further **scientific study**;
2. Promote **cooperation between the various players** involved in child nutrition;
3. **Correctly structure initiatives** according to the most effective international best practices;
4. Promote the spread of **correct nutritional information** and promote prevention.

1. Reference scenario

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The maximum potential of a child's genetic legacy can only be realized if he is nurtured in a balanced and correct way and if, at the same time, the child is able to live in a sufficiently healthy way, filled with love and attention.

School-age overweight and obese children number 155 million worldwide, equivalent to one out of ten. Of these, 30-45 million are classified as obese, which means 2-3% of children aged 5 to 17.

Joel Sartore/National Geographic Image Collection

1.1 Role of diet in children's health: the effects of over-eating and poor eating habits

Scarcity of food is a problem afflicting many developing countries and each year is the cause of death of millions of people, especially children, due to **malnutrition** (see box, "Child Malnutrition in Developing Countries").

But on the contrary, especially in Western countries, just as great a number (if not greater) of adult deaths is connected, paradoxically, to problems deriving from **over-eating** and **poor eating habits**.

In fact, the way in which we eat has an enormous influence on the appearance of certain pathologies – such as **obesity**, **type 2 diabetes**, **cardiovascular disease** and some types of **tumors** – which, over recent decades, have seen a significant increase.[1]

In all these illnesses, diet and physical activity are important modifiable factors which, in interaction with other genetic, environmental and social-cultural factors, assume an absolutely key role in not only fostering, but also preventing, the development of these diseases, with a resulting social and economic impact that is extremely signficant.[2]

Acquiring and maintaining nutritional and exercise habits in line with changed social-environmental needs is an absolute must for the well-being of present and future generations.

Obesity, in particular, is a true pathology which, in turn, increases the risk of developing diabetes, high blood pressure and heart disease.

The factors behind the origin of overweight and obesity are many. Some of these are only marginally or not at all affected by medical or preventive action because they are connected to genetic factors.

Others, on the other hand, do respond to preventive action aimed at modifying some aspects of behavior and habits in lifestyle, physical activity and diet. These initiatives must **begin in childhood**.

Childhood obesity is, in fact, a risk factor for obesity in adulthood: one obese child out of every two will be an obese adult.

Lifestyles and behavior learned during the developing years, such as food preferences, dietary composition, distribution of foods consumed throughout the day, portion size and the way foods are eaten, as well as a sedentary lifestyle, **can foster the development of overweight and obesity**.

1 *For a detailed description of the worldwide growth trends in chronic non-communicable diseases, see Chapter 1 of the "Alimentazione e Salute" position paper published by the Barilla Center for Food & Nutrition in September 2009.*
2 *Muoio A., Lipartiti F., Magnati G., "Alimentazione, stili di vita e salute"*

Child Malnutrition in Developing Countries

Today, 1.02 billion people in the world[3] suffer from hunger, 147 million people more than the previous survey (2006), and the worse level since 1970.

Approximately **one person out of six does not have enough food** to lead a healthy and active life.

On a worldwide level, hunger and malnutrition represent the primary risk for individual health–worse than the combined effect of diseases such as AIDS, malaria and tuberculosis.

"More than 17,000 children die of starvation every day, one every five seconds. Six million children a year. This is no longer acceptable. We must act".

Ban Ki-moon, Secretary General, UN, World Food Summit, Rome, November 2009

The main causes of this phenomenon can be traced to endemic poverty, war, natural disasters, inadequate or scarce infrastructure and farming equipment, and over-exploitation of the environment. In addition, the combined effect of the economic-financial crisis and food crisis has further complicated this scenario, contributing to an increase in the number of malnourished individuals.

Malnutrition causes 53% of the 9.7 million **deaths recorded in children** under five years of age in developing countries.[4]

In these countries, approximately 148 million children in this age bracket are **underweight** due to an acute or chronic shortage of food. This means that approx. 14% of those who suffer from hunger are children.[5]

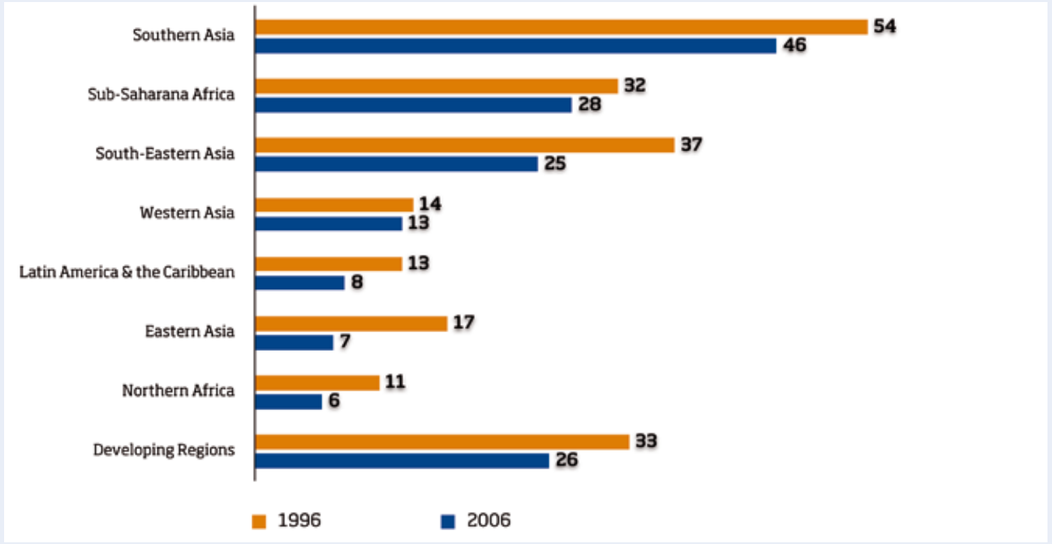
Often **child malnutrition is inherited from poor maternal diet**, both prior to and during pregnancy. In fact, 17 million children are born underweight each year; newborns who survive despite low birth weight tend to suffer from **retarded/limited growth**[6] and cognitive development, and are more susceptible to **infectious diseases**, both during childhood and adolescence, up through reaching adulthood. They will also have learning problems and health problems as adults.

Recent studies have also shown that there is a connection between malnutrition in early years, including the period in the womb, and subsequent development of chronic diseases such as diabetes, high blood pressure and heart disease.

3 *Source: FAO, 2009*
4 *World Food Programme 2008*
5 *"The State of the World's Children", UNICEF, 2009*
6 *Retarded growth (stunting) is considered height under the average for that age, associated with chronic shortage of nutritional substances and frequent infections. Stunting normally occurs before the age of 2 and its effects are often irreversible. Source: UNICEF Italy*

Karen Kasmauski/National Geographic Image Collection

Figure 1. Children under 5 years of age in conditions of malnutrition, percentage by region, 1990-2006



Source: The Millennium Development Goals Report, UN 2008

Although forecasts would tend to indicate that since 1990 the percentage of underweight children in developing countries has decreased from 33% to 26%, in some areas it still represents a significant problem. **South-East Asia** in general, and the **Indian sub-continent** in particular, **remain those areas of the planet with the highest numbers of underweight children**: their share of the local child population has decreased to just under 50%[7].

Hunger and malnutrition do not mean only an actual lack of food. These conditions are also manifested in other less-evident forms. With caloric intake being equal, the (often dramatic) lack of one or more micronutrients (protein, vitamins and minerals) fundamental for the correct functioning of the human body, indicates the presence of a condition known as "**hidden hunger**"[8].

The **lack of micronutrients impedes proper physical and mental development, makes people more susceptible to contracting infectious diseases, reduces productivity on the job and increases the risk of premature death**. Lack of vitamins and minerals is one of the main causes of death and disability in developing countries, especially among children.

In particular, **iodine**, **iron**, **vitamin A**, **folic acid and zinc** are the micronutrients that have been concentrated on because the effects of their lack are more evident and serious and because targeted action to eliminate these effects would seem easier to accomplish[9].

*7 These figures have also been recently confirmed by a World Bank study (**India - Undernourished children: a call for Reform and Action**", WB, 2009) which not only brought this problem to the attention of policy makers, but also pointed out that while in other parts of the world economic growth has brought an improvement in nutrition, in India this process has not occurred.*

*8 The **World Food Programme** estimates that "hidden hunger" affects over two billion people.*

9 A recent study performed by the World Health Organization in 52 European countries showed that in 17 of these countries micronutrients are considered a priority for public health initiatives ("Comparative analysis of nutrition policies in the WHO European region", Copenhagen, WHO Regional Office for Europe, 2006).

More than 3.5 billion people suffer from iron shortage (up to 47.4% of pre-school age children are anemic[10]), nearly 2 billion risk iodine shortage and 200 million pre-school age children show a lack of vitamin A.

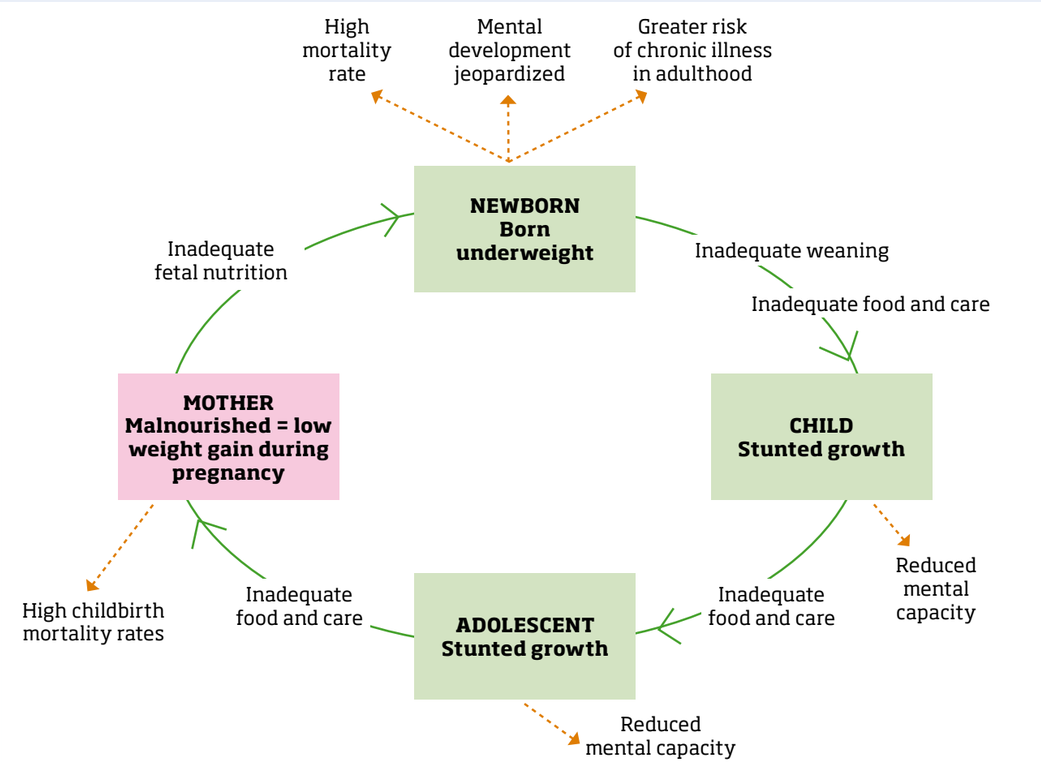
A **shortage** of iron can cause **retarded growth**, lower resistance to illness, disorders in reproductive functioning and a deficit in **mental and motor development**.

A **shortage of vitamin A** in children can cause **blindness** and can also contribute to **retarded physical growth** and reduced resistance to infection with a consequent increase in mortality in younger children. Each year, between one and three million children die due to shortage of vitamin A[11].

A **shortage of iodine** can cause **permanent brain damage**, mental retardation, sterility and a lowering of the probability of survival in children. A shortage of iodine in a pregnant woman can cause a range of levels of mental retardation in her unborn child. Throughout the world, 1.9 billion people are at-risk[12].

The first two years of life of a child are fundamental in preventing child undernourishment and malnutrition which are, to a great extent, the cause of irreversible damage. The activity of international organizations – such as, for example, the World Food Programme – is primarily concentrated on this critical age bracket in providing essential nutritional elements, including vitamins and minerals.

Figure 2. Primary effects of malnutrition in various phases of development



Source: The European House-Ambrosetti re-elaboration based on FAO

10 Data referring to children in developing countries.
11 "World Nutrition Situation 5th report", UN Standing Committee on Nutrition, 2005
12 "World Nutrition Situation 5th report", UN Standing Committee on Nutrition, 2005

Recently, these organizations have also been stimulated to identify/develop innovative nutritional methodologies.

In 2008, on the eve of World Food Day, the World Food Programme (WFP) charged its directors in over 80 countries with developing new types of foods using local products.

It also gave its private suppliers the task of **developing new foods** with these characteristics, while also establishing among the various quality standards that "*these products must be compatible with the local food culture and reproducible in quantities required locally, as well as being economically viable in terms of long-term costs.*"

An example of innovation in the area of food products which was developed in order to increase the nutritional capacity of foods and thus contribute to reducing the deficit of micronutrients which many people – especially children – suffer from is the **Golden Rice Project**, a Rockefeller Foundation initiative.

The idea dates back to the late 1980s and called for genetically modifying rice in order to produce varieties that would contain pro-vitamin A, a variety named Golden Rice.

When in 2000 the details of this scientific research project were published in the *Science Journal*, it was greeted as an ingenious solution and generated growing expectations.

However, since that time, a number of criticisms about its validity and efficacy have been raised.

In particular, many believe that, today, an approach aimed at resolving problems of malnutrition through genetically modified foods is not very convincing and effective.

In this paper, we will not be taking a position either for or against the validity of this solution since the debate is still actively on-going.

All we will note is that, on the basis of current knowledge in the nutritional field, it is important to act on the food system in its entirety, educating the world's populations to utilize everything available to them[13].

It should also be noted that eliminating undernourishment and malnutrition means ensuring sufficient **water resources** to meet both the food needs and basic hygienic-sanitary conditions of individuals.

Finally, it should be noted that **undernourishment and malnutrition also have a negative impact on the participation and academic performance** of children and that, very often, this influences their ability to generate income as adults.

Hunger and malnutrition, therefore, do not only affection individuals, they also **undermine the economic potential of developing countries**.

It has been estimated that each child whose mental and physical development has been altered due to hunger and malnutrition will see a 5-10% reduction in his or her ability to generate wealth over their lifetimes[14].

13 For example, local products such as mango and palm oil which are rich in vitamin A. (e.g., Drammeh, B.S., G.S. Marquis, E. Funkhouser, C. Bates, I. Eto e C.B. Stephensen, "A Randomized, 4-month Mango and Fat Supplementation Trial Improved Vitamin A Status among Young Gambian Children, J.Nutr. 132: 3693-369, 2002; Benade, A., "A Place for Palm Fruit Oil to Eliminate Vitamin A Deficiency", Asia Pac. J.Clin.Nutr. 12: 369-372, 2003); Monastra G., "Le Biotecnologie Vegetali di Fronte alla Sfida della Malnutrizione e della Fame nel Mondo", INRAN
14 World Food Programme 2009

1.2 Childhood obesity and its impact on health

Childhood obesity is a significant health, social and economic problem of increasing importance for Western countries.

It is the result of **long-term positive energy intake**: in essence, more calories are ingested than are burned off.

Obesity is defined, in fact, as an excess of fat mass. The extent of adipose mass and its proportions vary during the growth years, both on a subcutaneous and visceral level; in addition, measuring fat mass is difficult and diagnosis is only made on the basis of indirect evaluations.[15] Since subcutaneous fat and the relationship between body weight and height (Body Mass Index - BMI)[16] are closely correlated to total fat mass, the parameter most commonly used to estimate adiposity is BMI. Experts agree on the following points:

- Overweight children have a BMI in the 85th and 95th percentile in terms of sex and age;
- Obese children have a BMI above the 95th percentile.

Karen Kasmauski/National Geographic Image Collection

15 *Maffeis C., "Il bambino obeso e le complicanze. Dalla conoscenza scientifica alla pratica clinica", SEE - Florence, 2004*
16 *Body Mass Index (BMI), calculated as weight in kg divided by height in meters, squared.*

In children, overweight and obesity can cause a series of physical and psychological consequences that can be so serious that they manifest themselves in childhood (precocious consequences), as well as (often more serious) problems that may be more easily encountered in adulthood (late consequences).

The most frequent **precocious consequences** of childhood obesity are both metabolic (insulin resistance, dyslipidemia, glucose intolerance, high blood pressure) and non-metabolic in nature, such as osteoarticular (valgis of the lower limbs, articular pain, reduced mobility, flat feet), cutaneous (stretch marks, Acanthosis nigricans), hepatic (fatty liver), respiratory (desaturation and nocturnal apnea) and psychological pathologies (poor body image, eating disorders, depression).

Obesity involves emotional, social and psychosocial consequences that are significant for children and adolescents. Among these are bullying at school, associated in turn with the risk of depression and anxiety.

Obesity involves emotional, social and psychosocial consequences that are significant for children and adolescents[17].

Among these are bullying at school, associated in turn with the risk of depression and anxiety. In addition, overweight children have lower self-esteem and are more likely to be excluded by playmates and classmates (a critical aspect for their social and psychological development).

And finally, given their lower self-esteem, they are more susceptible to behavior with a negative health impact, such as drinking and smoking[18].

During developing years, **pathological anatomical alterations** of metabolic origin may also appear which makes obesity a condition of risk: increase in the thickness of artery walls, atherosclerotic plaques on coronary arteries and the aorta are connected to BMI from early infancy and are correlated to insulin resistance and fasting LDL cholesterol levels[19].

The most common of the **late consequences** of childhood obesity is **continuation of obesity into adulthood**: approx. 70% of obese adolescents remain so even as adults[20].

In addition, individuals who have been overweight/obese when young are more susceptible to cardio-circulatory (high blood pressure, heart disease), muscular-skeletal (early development of arthritis due to static-dynamic stress on spine and lower limb joints most subject to supporting weight) and metabolic pathologies (mellitus diabetes, hypercholesterolemia, hypertriglyceridemia, etc.), as well as eating disorders and cancer of the gastro-intestinal tract.

17 *Cortese S, et al., "The relationship between body size and depression symptoms in adolescents", J Pediatr. 2009*
18 *Lobstein T., Baur L., Uauy R., "Obesity in children and young people: a crisis in public health", Obesity Reviews, 2004*
19 *Maffeis C., "Il bambino obeso e le complicanze. Dalla conoscenza scientifica alla pratica clinica", SEE - Florence, 2004*
20 *Whitaker R.C., et al., "Predicting obesity in young adulthood from childhood and parental obesity", New England Journal of Medicine, 1997*

For example, a recent British study[21] confirmed that obese children run increased risk of developing diabetes and heart disease since **approximately half of overweight children and adolescents are affected by "metabolic syndrome"**.

In addition, increases in body weight and other obesity indices at a young age (but not only), can translate into a subsequent **increase in blood pressure**. One study which examined nearly 10,000 individuals born in 1958 in the UK[22], showed that for every weight level at birth, an excessive increase in weight in the first seven years of life was associated with an increase in blood pressure in adulthood.

In conclusion, a study recently published in the *New England Journal of Medicine*[23] which monitored nearly 5,000 American children born between 1945 and 1984, concludes that childhood obesity involves a **more than double probability of death by the age of 55** due to the increased risk of developing metabolism-related pathologies, heart disease, high blood pressure, etc.

Causes of childhood obesity

The genesis of childhood obesity is **multifactorial** given that it is the result of a range of interacting causes which are more or less evident.

Many genes compete in creating a predisposition for the development of obesity. On average, genes are approximately 50% responsible, while the remaining 50% can be traced to environmental, relational and physical factors.

Only rarely is obesity caused by glandular (hypothyroidism or adrenal gland disorders) or genetic diseases (monogenic obesity caused by highly-rare genetic defects, or syndromic obesity, for example Prader Willi syndrome). In the overwhelming majority of cases, obesity is the result of the interaction of genetic and environmental factors.

Many genes (more than 430 have been identified) compete in creating a predisposition for the development of obesity. On average, **genes are approximately 50% responsible, while the remaining 50% can be traced to environmental**, relational (family, friends, classmates, etc.) and physical factors (where one lives, climate, etc.)[24].

The effect of environmental factors on individuals susceptible to obesity fosters difficulty in efficiently regulating calorie levels to energy needs, causing more to be consumed than is actually required. A sedentary lifestyle facilitates this process.

Diet

Parents worry when their child eats too little, but rarely when he or she eats too much. Although it is true that an insufficient diet can cause a range of shortages (protein, calcium, iron, vitamins and other nutrients essential for growth), on the contrary, **excessive caloric intake results, first, in overweight in the child and, later, in the majority of cases, outright obesity.**[25].

21 *Ram Weiss et al., "Obesity and the Metabolic Syndrome in Children and Adolescents", The New England Journal of Medicine, 2004*
22 *Li L., Law C.; Power C., "Body mass index throughout the life-course and blood pressure in mid-adult life: a birth cohort study", Journal of Hypertension, June 2007*
23 *Franks P. W. et al., "Childhood Obesity, Other Cardiovascular Risk Factors, and Premature Death", The New England Journal of Medicine, Volume 362:485-493, February 11, 2010*
24 *Maffeis C., "Il bambino obeso e le complicanze. Dalla conoscenza scientifica alla pratica clinica", SEE - Florence, 2004*
25 *Dehghan M. et al., "Childhood obesity, prevalence and prevention", Nutrition Journal, 2005*

In addition to the total amount of calories (and, therefore, food **portions**), the composition of the diet can also contribute to developing and maintaining overweight. A **fat-rich diet** fosters the accumulation of lipids in three ways[26].

- **Calorie density**. Fats provide greater calorie density to foods and, as a result, if equal volumes of foods are consumed, the amount of calories ingested is greater. Since the sensation of satiety is influenced by the volume of food, foods with a high calorie density are less-filling than foods with lower calorie density;
- **Palatability**. Fats make foods tasty and this makes them more pleasing to the palate and fosters their consumption, thus increasing the total number of calories consumed;
- **Thermogenetic characteristics**. Characteristics of lipid metabolism mean that the consumption of fats is followed by them being efficiently turned into triglycerides. In fact, the energy cost of digesting, absorbing, metabolizing and storing fats is about 2-4% of the caloric content of the fats ingested, much lower than that of carbohydrates (5-24%) and proteins (25-30%). A significant relationship between the level of adiposity, expressed as the percentage of total body weight, and lipid content in the diet, expressed as the percentage of total calories consumed, has been clearly demonstrated in obese children[27].

The **fiber content of foods** is also important. Low fiber contributes to reducing the volume of the meal and rendering absorption of nutrients faster. In fact, both factors influence the mechanisms of satiety regulation and contribute to more calories being consumed compared with a fiber-rich, isocaloric meal.

In addition, hyperalimentation not only causes an increase in the volume of adipose cells (hypertrophy), but it also increases their number (hyperplasia). This phenomenon is more pronounced in the first two years of life, and during puberty is associated with an enhanced tendency towards obesity in adulthood, as well as difficulty in losing weight or keeping it within a set limit. This is because it is impossible to eliminate mature adipocytes once they have been fully differentiated.

Therefore, taking action during developing years is of fundamental importance because it can lead to better, and more long-lasting, results than those obtained during adulthood. Parents should be the first to notice excessive weight gain in their child and inform the pediatrician, the person best placed to help them. However, a good appetite is often seen as a sign of well-being and the tendency is to promote rather than try to limit it, with the illusion that the evident excess weight will disappear in puberty.

Children inherit from their parents' genes a tendency towards obesity, but through their relationship from birth, they learn from them motor and nutritional habits.

In addition to the high level of calories consumed (compared with those burned through activity), children's eating habits are often irregular throughout the day, with a prolonged exposition to easily-accessible food without adult control. This fosters consumption that is continuous and, above all, not always correct in terms of meeting the daily requirements for macronutrients, vitamins and minerals. As a result, therefore, not only do children frequently "eat too much" but also irregularly and too often badly.

26 *Maffeis C., "Il bambino obeso e le complicanze. Dalla conoscenza scientifica alla pratica clinica", SEE - Florence, 2004*
27 *Maffeis C, et al., "Meal-induced thermogenesis and obesity: is a fat meal a risk factor for fat gain in children?", J. Clin Endocrinol Metab., 2001*

Sedentary lifestyle

In addition to poor and unbalanced eating habits, another important risk factor is that of **reduced physical activity**[28] the result of a sedentary lifestyle caused by the rapid evolution of personal, family and social needs.

For example, children are often taken by car by their parents, even for short distances, and spend hours in front of different types of screens (TV, Playstation and computer)[29], often being exposed to negative role models that accentuate bad eating habits. They leave the house less and less, also because of parental apprehension over their safety[30]. They take part less-frequently in gym class (especially adolescent girls[31]), and so on. Numerous international studies have linked these behaviors with an increase in the prevalence of childhood obesity[32].

The continuous increase in the amount of time spent by young people in front of a screen is confirmed by an American study[33] which calculated that, in 2009, young people between the ages of 8 and 18 spent an average of 7 hours and 38 minutes per day utilizing various forms of media.[34] Compared with five years earlier (2004), this marked an increase of 1 hour and 17 minutes, and compared with ten years earlier (1999), 1 hour and 19 minutes.

Physical exercise, on the other hand, is of fundamental importance for the growth of a child. In addition to preventing excessive increase in body weight, exercise promotes a change in the proportion between lean mass (muscle tissue) and fat mass (adipose tissue). For this, it is sufficient to practice an aerobic activity of moderate intensity without tiring the organism too much. For example, riding a bicycle or walking which puts muscles under limited but constant stress and allows fuel to be utilized, above all, from stored fats.

Family and genetic factors

A multi-objective survey performed by ISTAT in 2000 demonstrates that 25% of overweight children and adolescents have an obese or overweight parent, while this percentage rises to approx. 34% when both parents are obese or overweight. This underscores how critical family factors are in the development of obesity.

Children inherit from their parents' genes a tendency towards obesity, but through their relationship from birth, they learn from them motor and nutritional habits.

In fact, in addition to genes, **the family model** is fundamental: it cannot be hoped that children will learn correct nutritional habits if their parents, first and foremost, do not follow a balanced diet.

In terms of the genetic contribution to obesity, the studies currently available have indicated that a number of genes (more than 430) are associated with overweight. However, it is not yet possible to predict the onset of obesity on the basis of genetic tests. A recent study published in *Nature*[35] and undertaken by a team of researchers from Cambridge University, analyzed the genome of 300 seriously-obese children and they found a correlation between partial DNA loss and serious obesity: the missing gene in obese children belongs to chromosome 16 which regulates hunger and blood sugar levels. The results of this and other interesting studies on this theme would require confirmation from studies on the general population before being able to utilize them in practical applications.

28 Maffeis C, et al., "Relationship between physical inactivity and adiposity in prepubertal boys", J Pediatr, 1997
29 Trembaly M.S., Willms J.D., "Is the Canadian childhood obesity epidemic related to physical inactivity?", International Journal of Obesity and Related Disorders, 2003
30 Gordon Larsen P., et. al., "Barriers to physical activity: qualitative data on caregiver-daughter perceptions and practices", American Journal of Preventive Medicine, 2004
31 Swinburn B., Egger G., "Preventive strategies against weight gain and obesity", Obesity Reviews, 2002
32 Dehghan M. et al., "Childhood obesity, prevalence and prevention", Nutrition Journal, 2005
33 Victoria J., et al., "Generation M². Media in the lives of 8- to 18-year-olds", a Kaiser Family Foundation Study, January 2010
34 Included in the study are television, audio and music, computer, video games, newspapers, books, magazines and movies.
35 Bochukova G., et al., "Large, rare chromosomal deletions associated with severe early-onset obesity", Nature 463, 666-670, 4 February 2010

The global emergency in childhood overweight and obesity: facts and figures

All Western countries are experiencing **exponential growth in the phenomenon of childhood overweight and obesity**.

According to data gathered by the international Obesity TaskForce[36], **school-age overweight and obese children number 155 million worldwide**, equivalent to one out of ten. Of these, 30-45 million are classified as obese, which means 2-3% of children aged 5 to 17.

Although not an isolated case, the **United States** is unquestionably paradigmatic in the trend of the spread of obesity and overweight in the youngest age bracket of the population (as well as among adults[37]). Some statistics, from 2001, indicate that 25% of American children are overweight and 11% are obese[38]. These numbers would seem to be confirmed by a more recent study carried out by the Trust for America's Health and

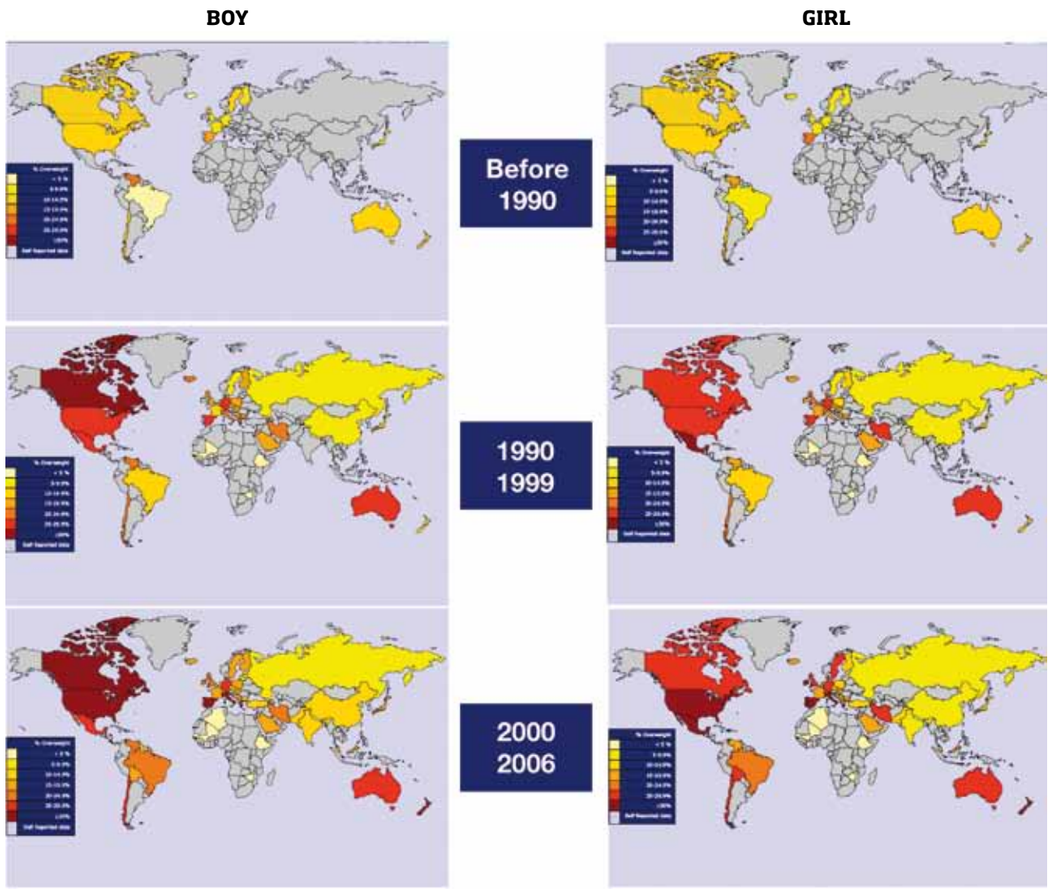
Gerd Ludwig/National Geographic Image Collection

36 Source: IASO - International Association for the Study of Obesity; IOFT - International Obesity TaskForce
37 More than 65% of all Americans are obese or overweight and approximately 31% of the adult population (more than 61 million people) would seem to fall within the definition of obesity [an individual is defined as obese if his or her body mass index (BMI) exceeds 30]. The National Institutes of Health further maintains that 4.7% of the adult population in America meets the criteria for what is defined as "extreme obesity" (with a BMI over 40).
38 Nicklas T.A., et al., "Eating Patterns, Dietary Quality and Obesity", Journal of the American College of Nutrition, 2001

the Robert Wood Johnson Foundation, according to which **almost one third of American children and adolescents are overweight or obese**. According to the National Institutes of Health, on the other hand, in addition to 16% of children between 6 and 19 who are currently overweight, a further 15% could be added very quickly from those currently under serious risk of becoming overweight.

The figures below clearly show how the rapid spread of this phenomenon over the last twenty years has not only affected the United States, but also all major advanced countries.

Figure 3. Prevalence of overweight in boys and girls on an international level, from the years preceding 1990 to 2006



Source: IASO, 2007

In Europe the problem of childhood obesity is also becoming increasingly common: each year in the member states of the European Union, approx. 400,000 children are considered overweight and over 85,000 obese[39]. In terms of childhood obesity alone, the prevalence in Europe today is 10 times greater than in the '70s[40].

Prevalence of childhood overweight and obesity in Italy

The problem of obesity and overweight in children has taken on growing importance also in Italy, both in terms of direct implications on the health of the child, as well as the risk factor it represents for the appearance of disease as an adult.

In Italy today, out of every 100 children in the third grade, nearly 24 are overweight (23.6%) and more than 12 are obese (12.3%). Overall, it is estimated that more than 1,100,000 children between six and eleven years of age have problems of obesity and overweight: more than one child in three.

In Italy today, out of every 100 children in the third grade, nearly 24 are **overweight (23.6%)** and more than 12 are **obese (12.3%)**.

Overall, it is estimated that **more than 1,100,000 children between six and eleven years of age have problems of obesity and overweight**: more than one child in three.

These figures and estimates are taken from the project "OKkio alla SALUTE"[41], a survey conducted in Italian schools by the Ministry of Employment, Health and Social Policy and coordinated by the National Institute of Health in collaboration with the Ministry of Public Instruction, Higher Education and Research, eighteen Italian regions, and with the participation of the National Institute of Research and Nutrition (Istituto Nazionale di Ricerca e Nutrizione - INRAN).

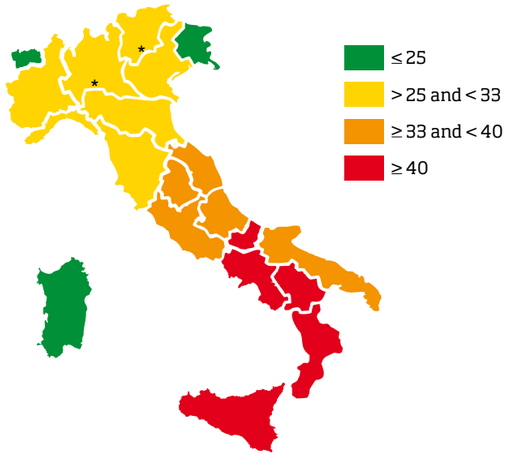
This survey is the first monitoring effort involving the population in developing years using uniform parameters and tools in conformity with the World Health Organization, that can provide a precise picture of the phenomenon in Italy, as well as homogeneous and comparable data utilizable for planning and evaluating chronic disease prevention initiatives.

This study, conducted by 1,028 specially-trained public health employees, measured the weight and height of approx. 46,000 children in 2,610 elementary schools, calculating the body mass index.

This has provided a "map" regarding overweight and obesity in Italian children which shows **significant differences between regions**, and above all between **North and South**.

39 Source: European Commission White Paper on Nutrition, 2007
40 Source: World Health Organization, 2008
41 Istituto Superiore di Sanità, "OKkio alla SALUTE: sistema di sorveglianza su alimentazione e attività fisica nei bambini della scuola primaria. Risultati 2008"

Figure 4. Overweight and obesity by region in children 8-9 years of age in the 3rd grade (map), 2008

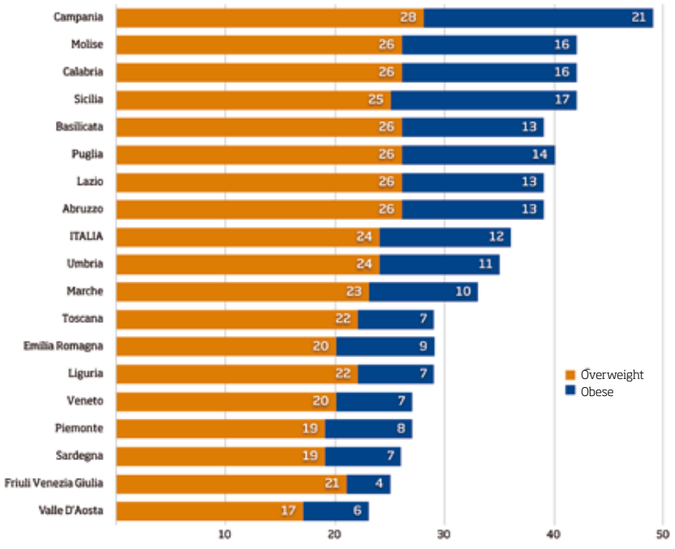


* Estimate date

Source: Istituto Superiore di Sanità, "OKkio alla SALUTE: sistema di sorveglianza su alimentazione e attività fisica nei bambini della scuola primaria. Risultati 2008"

Specifically, while overweight seems fairly widespread with values close to the national average of 24% in the various regions of the country, in terms of obesity, there are greater peaks with significant discrepancies with the national average in some areas of the South, led by **Campania** with a level of childhood obesity of 21%, followed by Molise, Sicily and Calabria, compared with a national average of 12% and lower levels of 4% in Friuli Venezia Giulia, 6% in the Valle d'Aosta and 7% in Sardinia, Veneto, Liguria and Tuscany.

Figure 5. Overweight and obesity by region in children 8-9 years of age in the 3rd grade (regional data), 2008



Source: Istituto Superiore di Sanità, "OKkio alla SALUTE: sistema di sorveglianza su alimentazione e attività fisica nei bambini della scuola primaria. Risultati 2008"

This survey also highlighted the widespread presence among children of **nutritional habits** which do not promote balanced growth and which foster weight gain, especially in the presence of more than one factor. Specifically, the survey found that:

- 11% of children do not eat breakfast;
- 28% eat an insufficient breakfast;
- 82% eat a mid-morning snack that is too rich (over 100 calories);
- 23% of parents declare that their children to not eat either fruit or vegetables every day.

The data gathered regarding **physical activity** are also not very comforting. Only one child in ten is involved in adequate physical activity for his or her age, and one out of four had not engaged in physical activity the day prior to the survey. In addition, half the children have a television in their own room.

Finally, the perception of the problem by parents would seem to be inversely proportional to the statistical frequency of overweight: four mothers out of ten with overweight children do not think that their child weighs too much compared to his or her height.

1.3 Economic impact of childhood obesity and overweight

The European Association for the Study Of Diabetes (EASD) has called prevention and treatment of obesity "the most important public health problem in the entire world". In fact, in addition to its health-related aspects, obesity and overweight also generate a **significant negative effect on healthcare costs**.

While the consequences of childhood obesity and overweight on public health are well-documented in the literature, to-date the economic impact on the health care system and society has only been quantified by a very limited number of studies and publications.

Of these, of significant interest are the results of a recent study[42] conducted on young Americans between the ages of 6 and 19 during the years 2002 and 2005 and based on data from a major national statistic survey (Medical Expenditure Panel Survey - MEPS).

What emerges from this study is that subjects considered obese in both years generated incremental health care costs of 194 dollars for outpatient visits, 114 dollars for prescription medicines and 12 dollars for emergency care, compared with children of normal weight.

The young people considered obese in one year or other of the survey, or in both years, generated incremental health care costs of 79 dollars for outpatient visits, 64 dollars for prescription medicines and 25 dollars for emergency care, compared with children of normal weight.

Extrapolating this data for the entire nation, it can be seen that obesity and overweight among young people generate **incremental costs for the American health care system of 14.1 billion dollars per year** for outpatient visits, medicines and emergency care.

42 *Trasande L.., Chatterjee S., "The Impact of Obesity on Health Service Utilization and Costs on Childhood", **Obesity**, September 2009*

2. Relationship between diet and health in children and adolescents

Karen Kasmauski/National Geographic Image Collection

The major risk for developing chronic diseases during one's life span, as well as developing them precociously, is strongly influenced by the eating habits and lifestyle children acquire during childhood and adolescence.

Regular motor activity fosters the maintenance of proper body weight and fitness, makes adolescents stronger and accustoms them to adopting a lifestyle that will make them healthier in the years to come.

Tyrone Turner/National Geographic Image Collection

2.1 Primary changes occurring in children and adolescents as they grow

Growth is a continuous process which begins at conception and ends with the attainment of sexual maturity. Somatic growth accompanies neuro-psychic growth.

This extended journey can be briefly subdivided into three periods distinguishable for the particular anatomical-physiological and mental changes occurring in the child: childhood, adolescence and young adulthood.

The behavior of the mother and father are critical in terms of both the growth and development of the child, teenager and young adult. Each of these periods requires a different parental approach. The overall ways of interacting, but also hygienic standards, discipline, diet and pedagogy specific to each phase of growth are important for the best possible end result.

The first phase, **childhood**, may be divided, in turn, into:

- **infancy**: this extends from birth through the first two years of age and includes the periods identified as newborn (first month of life), unweaned and weaned (first teeth);
- early childhood or **pre-school**: from ages 3 to 5;
- middle childhood, or "**school-age**" which covers the period from ages 6 to 11.

The second phase is adolescence (or puberty), and includes the period between ages 11 and 18 in boys and 11 and 16 in girls.

And finally, **young adulthood**, which goes from ages 18 to 25 in boys and 16 to 20 in girls.

These three phases refer to the growth of the child from an anatomical, physiological and behavioral standpoint, starting from the moment of birth. Actually, however, growth begins **thirty days following conception** when the body is four millimeters long and the head is as large as that of a pin. The heart beats 65 times per minute, but the arms and legs are not yet present. Only five days later (day 35), do the arms and hands begin to appear at the sides of the body. Following this, the arms and shoulders begin to take shape and by day 40, the first indentations of the fingers begin to form and by day 45, these are visible. At three months, the fetus is approximately nine centimeters long. The lower part of the body is still not very formed. At seven months, the child continues to grow, reaching two-and-a-half kilos in weight. At this age, the growth and functioning of the various organs is basically complete and sufficient to guarantee survival, even outside the mother's womb, but this will only be optimal at the end of the full nine-month gestation period.

The behavior of the mother and father are critical in terms of both the growth and development of the child, teenager and young adult.

For this rapid growth, large amounts of nutritional substances, oxygen and water are required. During this period, the fetus is an autonomous being with its own blood circulation and all organs which gradually begin to function on their own. The umbilical cord is the sole connection between the child and the placenta. Fetal nutrition depends completely on the mother and functioning of the placenta.

Early childhood (from birth to age 5)

From the moment of birth, the primary changes involve weight, length of the body, the cranium, dentition, stomach and cardiovascular system:

- the normal average **weight** of an Italian newborn is approx. 3,250 grams for males and approx. 3,110 grams for females. During the first six months, weight increases by approx. 20-30 grams per day, and 10-15 grams per day during the second six-month period. The weight of a newborn doubles by the fourth month, triples at one year and quadruples at two years;
- The **length** of a full-term newborn's body is ca. 50 cm. This increases 8 centimeters every three months for the first two three-month periods, while from the age of 6 to 12 months, it will increase by only 8 cm. Generally, a baby is approx. 50 centimeters long at birth, 70 centimeters long at its first birthday and 80 centimeters long at age two;
- In newborns, the **cranium** is large compared with the body. It is equal to one-fourth the length of the entire body (in an adult it is seven-eighths), and this is because the lower limbs, which are short at birth, subsequently grow much more in comparison with the head and trunk. The cranial bones of an infant are not fused, but rather divided with membranous spaces known as "fontanels" which close between months fourteen and sixteen;
- **Dentition** begins in the sixth to eighth month and lasts until adulthood. It is divided into two major phases: first dentition (from approx. 6-8 mos. to 25-30 mos.) with the appearance of 20 teeth and the second dentition (from approx. 5-6 years to 20-30 years), to reach the full set of 32 teeth;
- The **stomach** has a capacity of 30-40 cc at birth, which increases gradually to 250 cc by the age of one year. At birth, the cardias (the area which joins the esophagus and stomach) is not able to fully perform its function of preventing the reflux of gastric juices back into the esophagus, a function children acquire later, normally at around 18 months. The slow maturation of the valvular function of the cardias helps to explain both the regurgitation and the ease of vomiting typical in unweaned infants. In proportion, the liver of unweaned infants is much larger than that in adults;
- The **cardiovascular system** is characterized by a spherical heart and a major axis that is virtually horizontal. During the subsequent development phase, the heart rotates and the major axis takes its more vertical position. At birth, pulse rate is very high (130-180 pulsations per minute), but gradually decreases and by the second year it is 120 pulsations per minute, around the age of 4-5 years, it drops to 100, then to 90 around the age of ten, and, finally, around the age of fifteen, the heart rate becomes that of an adult. Respiration is superficial, abdominal in type. Inspiration is shorter and expiration longer. Frequency of respiration in newborns is very high (40-50 respiratory acts per minute) and gradually diminishes to 25 respiratory acts per minute at the age of one.

A diet particularly lacking in nutrients or neglect or abandonment can cause a reduction in the development of the child's actual potential for growth–for example, failure to meet his/ her genetically-programmed height.

In general, the weight and height of a healthy child depend primarily on **genetic characteristics** inherited from its parents and by **living conditions** pertaining to **diet, hygiene, physical environment and affective relations**. The maximum potential of a child's genetic legacy can only be realized if he is nurtured in a balanced and correct way and if, at the same time, the child is able to live in a sufficiently healthy way, filled with love and attention. Unfavorable external situations, such as a diet particularly lacking in nutrients or neglect or abandonment can cause a reduction in the development of the child's actual potential for growth–for example, failure to meet his/her genetically-programmed height.

Similarly, **psychomotor** development is heavily influenced by the external conditions surrounding the child. The elaboration of the full range of different stimuli will result in the full acquisition of multiple modes of reacting and behaving. This process takes place very rapidly in the first years of life and reaches completion only after many years.

Starting at age two, neuropsychic development in children is characterized primarily by movement, language and relational modes:

- **Around the age of two**: the child first attempts to run. He can understand speech not specifically directed to him and the value of adjectives. He can express what he wants.
- **From the age of two-and-a-half to three**: he is able of climbing the stairs. He can form phrases and ask questions. Play extends to include children of the same age, opening the way to social relationships.
- **From three to four years**: he can hop on a single leg. He can dress by himself and button his clothes, exhibiting, therefore, enhanced independence. He uses words which are comprehensible, asks a lot of questions and is able to construct long and complex sentences. He frequently plays with others.
- **From four to six years**: he is able to jump, switch from foot-to-foot, thus demonstrating evolved motor ability. He uses complex sentences and fluent language with small, rare errors in pronunciation and grammar. He understands most of what he hears.

To summarize, this is a particularly rapid and complex phase of growth, both in terms of physical and intellectual-behavioral (psychomotor) growth.

School-age (6 to 11 years of age)

The start of school coincides with the child's full entry into society. Once the phase of rapid physical and psychomotor growth which characterizes infancy and early childhood has been concluded, during school-age, growth is slower, but remains constant (approx. 2 kg in weight and 6 cm in height per year). This phase sees the further development and maturation of the child's character and personality and the child begins to take on his first commitments and responsibilities and establish broader social relations.

The role played by the presence of playmates and classmates becomes increasingly important. A **process of personal and group socialization** begins, characterized by a growth in intelligence and accentuation of the child's own sensitivity to what surrounds him.

The child begins to be involved in an increasing number of **activities**, from school to sports. The activities gradually lead to personal responsibilization since the activities in which the child is involved begin to be evaluated both by his parents and people outside the family.

Adolescence (11 to 16 years of age)

Adolescence is a phase of growth which marks the passage from childhood to adulthood. This passage requires that the individual achieve his own independence and build his own identify outside the family. This creates within young people the desire to rebel against their families and parental authority, which they express with behavior that is intolerant and defiant, and with radical emotional ups-and-downs.

Adolescence is characterized for all by major biological changes involved in puberty and the highly intense **emotional experiences** connected with these which are due to the bodily changes and impulses which drive the adolescent to search out new equilibriums in his relationship with the world and with himself, as well as the precocity or delay in these changes compared with others of his own age, which can give rise to anxiety and uncertainty.

On the other hand, these physical changes mean that the adolescent is treated by those people with whom he is normally in contact – as well as by strangers – in a different way than when he was a child. The demands made of him are different, he is expected to act as an adult, even if, at the same time, he is still not considered autonomous or capable of making certain decisions about his future on his own.

The adolescent is especially aware of this change in relationships and, on the basis of it, changes his own behavior towards himself and the world around him. The first indicator of this change–and often a conflictual one–is seen in the fact that the adolescent no longer accepts to be totally dependent on his own family and the various forms of social-emotional support the family has provided up to that point.

Other changes pertaining to the world around him are triggered by the increase in the number of stimuli the adolescent pays attention to on the basis of an increase in his own interests tied to his emotions and feeliings, as well as the outside world. The acquisition of independence, even partially, allows him to embark on new activities and adopt different modes of behavior connected to new modes of interacting with others. The changes which occur call into question the modes of presentation and schema which, up to this moment, have governed the individual's relationship with his own body, with other individuals and groups, and with activities, objects and social institutions.

Alaska Stock Images - National Geographic Image Collection

2.2 Why has diet become a critical issue? Relationship between diet and chronic diseases in children

The relationship between excessive body weight and an increase in the risk of contracting chronic diseases has been amply documented for adults. But for children, public opinion (or the public) continues to have difficulty accepting that this relationship exists. In fact, studies conducted to-date have shown the importance of **conditions of risk** and **behavior** in childhood that foster the appearance of chronic diseases (cancer, cardiovascular disease and diabetes) in later years.

In particular, the existence of a relationship between **eating habits** (in terms of amount and dietary composition) adopted during childhood and adolescence and chronic diseases contracted in adulthood has been demonstrated.

One of the first studies, conducted in the 1930s by Boyd Orr[1] and taken up again in 1998 by Frankel, Gunnel and Peters,[2] confirms the existence of a positive relationship between the **amount of calories** consumed during growth and the **death rate from cancer during adulthood**. The recent review conducted by the International Agency for Research on Cancer[3] (IARC) reached the same conclusions, highlighting a connection between obesity (both in childhood and adolescence) and the risk of contracting chronic diseases. Must and Limpman[4] demonstrated that proteins, especially those of animal origin, if eaten in excess, can promote weight gain to the point of obesity and, as a consequence, increase the risk of contracting diseases such as breast, uterine and colon cancer.

The state of health in adulthood is also determined by the **family, social and economic context** in which a child grows. Social deprivation and malnutrition during childhood has been linked to the risk of contracting cardiovascular diseases and diabetes in adulthood. Similarly, the presence of overweight people in the family leads to a higher risk of adopting a diet that is unsuitably excessive, both quantitatively and qualitatively, acquiring sedentary habits and becoming obese[5].

The presence of overweight people in the family leads to a higher risk of adopting a diet that is unsuitably excessive, both quantitatively and qualitatively, acquiring sedentary habits and becoming obese.

Three critical factors, if not avoided during adolescence, can have a significant impact on the risk of contracting chronic pathologies during adulthood:

- exposure to **risk factors**, such as adopting an unhealthy diet, drinking or smoking, or manifesting excessive weight gain;
- following a **sedentary lifestyle**, for example, replacing hours of physical activity with watching TV, playing videogames or sitting in front of a computer;
- **ignoring prevention** and controlling risk factors.

The combination of these three factors can produce immediate effects (obesity, insulin resistance, dyslipidemia, high blood pressure) and, at the same time, generate long-term effects, such as acceleration of processes leading to **diabetes** and **cardiovascular disease** in adulthood[6].

1 *1949 Nobel Prize for Peace for his scientific research into nutrition.*
2 *Frankel S, Gunnel DJ, Peters TJ, "Childhood energy intake and adult mortality from cancer: the Body Orr Cohort Study", British Medical Journal, 1998*
3 *International Agency for Research on Cancer, "Weight control and physical activity", 200*
4 *Must A., Lipman RD., "Childhood energy intake and cancer mortality in adulthood", 1999*
5 *Scaglioni S., Agostoni C., De Notaris R., Radaelli G., Radice N., Valenti M., Giovannini M., Riva E., "Early macronutrient intake and overweight at five years of age", 2000*
6 *Bao W et al., "Persistence of multiple cardiovascular risk clustering related to Syndrome X from childhood to young adults", 1998*

A study conducted in China[7] reveals that for children affected by obesity in the first years of life (from 1 to 3 years of age) the risk of being overweight as an adult is 2.8 times higher than for a child of normal weight. Underweight is also a risk factor. In fact, the same study found that children who were underweight during the first years of life run 3.6 times the risk of being underweight as adolescents than children of normal weight.

To conclude, the major risk for developing chronic diseases during one's life span, as well as developing them precociously, is strongly influenced by the eating habits and lifestyle children acquire during childhood and adolescence. Therefore, preventive action taken from the very first years of life through direct actions, such as adoption of a balanced diet and healthy lifestyle, is fundamental to keeping the various risk factors under control and significantly limiting the onset of chronic diseases so common in adulthood.

2.3 Relationship between diet and health in pre-school and school-age children: relationships and principles

During early childhood–characterized by rapid growth–it would seem very necessary that children be provided with **an adequate amount of energy**. The **macronutrients** contained in foods that can provide children with energy are **fats, carbohydrates and proteins**. To comprehend how important the amount of energy is, especially in the first years of life, it can be seen how (for each gram of macronutrients consumed per unit of body weight) the quantity of protein consumed by a child in the first years of life is almost the same as that for an adult, but carbohydrates are almost double those consumed on average by an adult, and the amount of fats is almost four times that of an adult.

Energy is required to maintain vital activity (respiration, cardio-circulatory activity, renal and cerebral functions) under conditions of rest (basal metabolism), to assure the processes of digestion, metabolism and storage of nutrients (thermogenesis), for laying of new tissue (growth) and physical activity. The energy a child should receive through diet equals the amount of energy utilized (basal metabolism, thermogenesis and physical activity), as well as the energy utilized for growth (i.e. used to generate new tissue).

During the first year of life, the amount of energy required for growth is significant compared to the total, but it decreases rapidly: in fact, it goes from 35% during the first month of life to 5% at one year. After the first year and up to the age of 9-10, the energy spent on a daily basis by a child is 50-60% for **basal metabolism**, 30-40% for **physical activity**, 5-8% for **thermogenesis** and only 2% for growth.

The World Health Organization (WHO)[8] reports a basic similarity between the recommendations provided by the United Kingdom, US, European Union and WHO itself in terms of the **energy required by a pre-school aged child. There exists, therefore, a range of considerable, overall reliable values** derived from the product of the estimate of the amount of energy required per kilogram of body weight and the average weight of the child for a number of general age brackets.

7 *Wang Y., GE K., Popkin BM., "Tracking of body mass index from childhood to adolescence: a 6-y follow-up study in China", 2000*
8 *WHO Regional Office for Europe and UNICEF, "Feeding and Nutrition of Infants and Young Children", WHO Regional Publications, European Series, No. 87, 2000 (updated reprint 2003)*

Average recommended amount of energy to be consumed in the diet (kcal/day)[9]

Age of child	Country/Organization		
	Italy	WHO	USA
age 1-3	768-1094	906-1088	806-1377
age 4-6	1417-1667	1204-1398	1453-1613
age 7-10	1792-2034	1500-1916	1694-1957

This table provides average values which may vary significantly on the basis of weight characteristics, body make-up and average level of physical activity of the individual child.

If the **energy level** is **lower than the necessary minimum level**, there may be serious retardation in the growth of the child and his/her ability to normally engage in physical activity, especially in pre-school age children. Prolonged periods of a shortfall in energy can create conditions of actual malnutrition and/or lead to a reduction in protein reserves tied to the use of stored proteins to generate energy.

On the other hand, excessive levels of energy compared with what is actually required, foster excess fat deposits and accelerated growth in both height and weight. Excessively fast growth in phases immediately following birth is considered a risk factor for the appearance of obesity in later years.

Therefore, also on the basis of increased obesity in children and adolescents, the WHO suggests that **excessive consumption of fats and sugars be limited from the earliest years**.

As stated earlier, the main macronutrients required for correct energy levels in pre-school- and school-age children are proteins, fats and carbohydrates.

Proteins represent an essential component–both functionally and structurally– for human cells and for this reason **an adequate protein level is fundamental, especially during pre-school- and school-age years**, an age in which the body is growing and requires amino acids to generate new tissue (especially organs and muscle). In addition, some amino acids essential to the human body cannot be synthesized directly by the body and must be introduced through diet: this can only occur through a **diet with a broad variety of protein sources**.

Excellent sources of high-quality protein are **animal liver**, **meat**, **fish**, **cheese**, **milk** and **eggs** and some products of vegetable-origin, such as products derived from **soybeans**, **green beans** and **legumes**. **Products derived from wheat** also constitute a source of protein, but the majority of vegetables and fruits contain only a limited amount.

Proteins may be classified in terms of the number of essential amino acids they can supply and, therefore, that they are able to guarantee the body enough support for protein synthesis to support a sufficient level to maintain body structure and functions as well as, in children, growth of new tissue.

9 Values reported in the tables of this chapter refer to the following documents: Italian Nutrition Society, "L.A.R.N.", 1996 update; FAO Nutrition and consumer protection division, "Nutritional requirements reports"; Food and Nutrition Board (Institute of Medicine of the National Academies), "DietaryReference Intakes", 2006.

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From this standpoint, all animal proteins are complete (i.e., they contain all the essential amino acids), while the majority of vegetable proteins (with the exception of soybean) are not complete because they supply an assortment of amino acids which is not correctly balanced and cannot, alone, meet the body's needs.

Therefore, **it is essential that a proper mix of amino acids be consumed through diet** through forms of "**protein complementation**" between foods with different protein content.

In terms of the **overall amount of protein it is felt is necessary during pre-school- and school-age**, the WHO stresses the **absence of significant evidence deriving from direct measurement of requirements**.

Therefore, all the official recommendations currently available are based on estimating the average level of protein consumption found in the reference population for a given age.

Normally, two standard deviation values higher than the average consumption levels given are considered a "safety margin" in order to find within the information given the requirements for the majority of children.

Average recommended amount of protein to be consumed in the diet (grams/day)

Age of child	Country/Organization		
	Italy	WHO	USA
age 1-3	13-23	13,5-15	13
age 4-6	21-28	17,5-24	19
age 7-10	29-42	30-42	27

Protein intake lower than that recommended, if also accompanied by insufficient caloric levels, causes an actual state of **protein-energy malnutrition**, especially if it continues over time. In less-serious cases, children manifest a weight-height ratio lower than that expected for their age (**low weight**); in chronic and more serious cases, the height-age ratio is lower than average (**growth retardation**) and often connected to a significant shortage in the micronutrients required by the body.

Acute, chronic protein shortage directly tied to diet (**primary malnutrition**) is especially common in children from developing countries, while in developed countries a less-serious type of protein shortage is seen which is connected with gastro-intestinal problems or chronic systemic dysfunction, such as tuberculosis, cystic fibrosis and cancer (**secondary malnutrition**). Nonetheless, all the less-serious forms of protein shortage caused by incorrect/insufficient diet can also occur in Western countries, in particular under conditions of poverty or with diets parents mistakenly believe are adequate, but are actually incapable of providing sufficient protein to the child.

In developed countries, the main protein disorder is tied to excessive consumption of proteins in the diet, rather than a shortage of them. In fact, the food normally consumed in Western families contains an amount of protein that is 3-4 times greater than the level considered adequate to satisfy the needs of pre-school- and school-age children.

Protein-rich diets do not provide significant benefits and, on the contrary, can have negative effects. The liver and kidneys might not be capable of metabolizing too-high a level of amino acids. This could cause the appearance of metabolic acidosis and there could be high levels of ammonia and urea in the blood. Finally, a relationship has been found between high protein consumption in pre-school-age (age 2) children and obesity during school-age (age 8). This is an important, but still preliminary observation which needs to be confirmed by further research.

Together with protein, the second macronutrient essential for guaranteeing a correct and balanced energy level for children is that of **fats**.

Fats consumed in the diet represent for children a **source of energy and essential fatty acids**. In particular, long-chain polyunsaturated fatty acids contain specific and important physiological functions.

Structural fats are an essential part of the cell membrane, neural fabric and overall cellular structure, while **stored fats**–present especially in adipose tissue, primarily composed of triglycerides–provide a long-term energy reserve for the body.

Consumption of fats in foods also provides for optimal absorption of liposoluble vitamins (A, D, E, K).

In general terms, from the period of nursing forward, the share of energy consumed deriving from fats tends to gradually decrease over the years (starting from a level of 50% in mother's milk). In terms of the overall amount of fats children should consume as part of their diet, the WHO suggests that–in the passage from weaning to pre-school age, i.e., **around the age of 2–30-40% of total energy intake** should be from fats. The Nemours Foundation[10] stresses that fats and cholesterol play an important role in child growth, especially in terms of cerebral development and should not be reduced in the diet below certain limits: specifically for small children (**2-3 years of age**), calories from fats should be **30-35% of total caloric intake**, while from the **age of 4 on up it should be 25-35% of the total**.

Thus, **diets lacking in fats would appear not to be suitable, especially for pre-school age children**. The main reason for limiting the amount of fats in the diet of pre-school age children is tied to the possible connection between lipid levels and the **onset of obesity** and **cardiovascular problems** during adolescence and adulthood. In addition, obesity is the result of a chronically-positive caloric balance, in which consumption of all energy-rich nutrients (carbohydrates, proteins and fats) in the diet plays a part. The high palatability and energy density of fats can mean that more of them are (unknowingly) consumed, thus impacting on overall calorie levels. This can cause the deposit of lipids in adipose tissue with an increase in overall adiposity, up to obesity. However, to-date, a definite causal relationship between lipid levels and obesity, independent of overall caloric instake, has not been demonstrated. The main existing evidence regarding a relationship between consumption of fats in small children and subsequent cardiovascular problems would seem to be indirect and often extrapolated from studies conducted on adults and children suffering from hypercholesterolomia. Nonetheless, as noted by the WHO, although further research to identify a definitive causal nexus between reducing consumption of fats in small children and reduction in the risk of developing cardiovascular diseases in subsequent periods of life is required, numerous and authoritative studies have clearly shown that prevention during childhood years against the primary risk factors of cardiovascular disease is fundamental. Regarding this, as suggested by Simell et al. (2009)[11], the amount and level of fats consumed in the diet during childhood determine the levels of lipoproteins in blood serum just as it does in adults, thus underscoring the importance of extending the same nutritional recommendations formulated for adults also to children.

Diets lacking in fats would appear not to be suitable, especially for pre-school age children.

In addition, Whitaker et al. (1997)[12] showed the existence of a relationship between overweight in childhood and continuation of obesity in adulthood.

Numerous studies (e.g., Robert Olson[13], 2000) indicate the limits–tied above all to the research carried out to-date on this issue–of positions in favor of a *significant* reduction of fats in the diets of children. In particular, the long-term safety of low-fat and low-cholesterol diets would seem to be controversial, given that such diets could deprive the child

10 *The Nemours Foundation Center for Children's Health Media is a body accredited by the U.S. Department of Agriculture, U.S. National Institutes of Health and U.S. National Library of Medicine*

11 *Simell O, Niinikoski H, Rönnemaa T, Raitakari OT, Lagström H, Laurinen M, Aromaa M, Hakala P, Jula A, Jokinen E, Välimäki I, Viikari J; STRIP Study Group; **"Cohort Profile: the STRIP Study (Special Turku Coronary Risk Factor Intervention Project), an Infancy-onset Dietary and Life-style Intervention Trial."**, International Journal of Epidemiology, 2009 Jun, 38(3):650-655.*

12 *Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH., **"Predicting obesity in young adulthood from childhood and parental obesity."**, New England Journal of Medicine, 1997 Sep 25, 337(13):869-873.*

13 *Robert E. Olson, **"Is it wise to restrict fat in the diets of children?"**, Journal of The American Dietetic Association, January 2000, Volume 100, Number 1.*

(during the delicate growth phase) of the proper overall levels of calcium, zinc, magnesium, phosphorous and vitamins. In addition, the possibility of a *direct* connection between reduced fat levels in childhood and correct eating habits in adulthood, does not seem to be proven scientifically.

Recommended amount of fats to be consumed in the diet (% total calories)

Age of child	Country/Organization		
	Italy	WHO	USA
age 1-3	30	<30	30-40
age 4-6	30	<30	25-35
age 7-10	30	<30	25-35

Carbohydrates are the third and most important source of energy (in terms of quantity) for the body. Once transformed into monosaccharides (glucose), **carbohydrates** in food provide **energy to all tissues in the human body, especially the brain and red blood cells which normally utilize glucose as the "fuel" for cell activity**.

When the level of glucose in the blood exceeds given amounts, this is normally removed by the blood and accumulated as glycogen or converted and stored as fat.

Carbohydrates not absorbed in the small intestine are transformed in the colon into lactic acid and short-chain fatty acids. These metabolites, together with a number of oligosaccharides, also promote the acquisition and maintenance of adequate trophism of intestinal mucous, including through the prebiotic effect on the microbic flora of the intestine.

There are three basic categories of carbohydrates contained in foods: sugars, starches and fiber.

Sugars are a **primary source of energy**, but do not contribute significantly to the body in any other way. For reasons tied to creating correct long-term eating habits that will also be of benefit during adolescence and adulthood, the WHO believes that (besides the effects on health in general) **a diet excessively-rich in sugary foods and drinks during pre-school and school-age years is not correct**. The importance of introducing even small children to a varied diet both in terms of nutrients and flavors is also stressed, so that they become used to accepting tastes other than sweet ones, normally favored at that age.

A diet excessively-rich in (added) sugars can reduce the energy intake from other important sources and, with this, the consumption of micronutrients, minerals and vitamins so necessary to a growing body. It can also cause intestinal disorders (diarrhea).

Numerous countries and organizations recommend that the **daily amount of added sugars not exceed 10% of total caloric intake** (in the case of pre-school children, this means, on average, no more than 25g of sugar per day). A level of sugar intake equal to or greater than 30% of the total caloric intake would seem capable of generating **significant health problems for children**: in particular, a significant increase in glucose, insulin and lipid levels in the blood (as shown in, among others, a

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report of the UK Department of Health[14]). Should they arise, these high levels must absolutely be taken on, primarily by replacing the excess sugars in the diet with foods rich in starches, fiber and micronutrients (for example, fruit and vegetables).

In terms of correct eating habits – especially for foods consumed at breakfast and as an afternoon snack – **yoghurt**, **non-sugared cereals** and **fruit** should be preferred by parents over foods with a high sugar content.

According to the WHO, a diet excessively-rich in **starches** – found primarily in products derived from **grains**, potatoes and **rice** – could be inappropriate in early years, despite the fact that starches are easy to digest and absorbed by the human body.

Numerous countries and organizations recommend that the daily amount of added sugars not exceed 10% of total caloric intake.

An increase in overall consumption of starches is generally recommended as the child grows (school-age), although it should be remembered that studies done on the effect of starch-rich diets in pre-school- and school-age children are still not that numerous.

The third main category of carbohydrates is that of **fiber**, which have a **number of positive effects on the health of children, from the earliest years of life**. In particular, fiber appears to have a beneficial effect on how fast food passes through the intestine (regularizing the alvus), on the characteristics of intestinal absorption (slowing the absorption of nutrients, in particular cholesterol and glucose) and on

14 Department of Health, United Kingdom. "Dietary sugars and human disease", London, The Stationery Office, (Report on Health and Social Subjects, No. 37).

the risk of becoming overweight (contributing to lessening the caloric density of the diet and increasing satiety).

wIn fact, foods with high fiber content have a low energy density[15], reduce the after-meal glycemic response and are excellent for satisfying hunger and limiting the overall amount of food consumed with beneficial effect also for digestive processes.

Despite the fact that, once again here, there have not been many studies performed about the assumption of various amounts of fiber in children, **there do not seem to be any special contraindications for the consumption of fiber by school-age children**, for whom the advantages from a diet suitably rich in fiber are greater than any possible limitations associated with it. However, the situation would appear different **for pre-school age children**, especially very young children, for whom **a diet excessively-rich in fiber could reduce the consumption and absorption of macronutrients and some minerals and vitamins** fundamental during these years, with potential consequences for growth.

Fruit and vegetables are, therefore, foods which are highly-recommended as part of a pre-school child's diet and–if possible, even more so–for school-age children. Fruit and vegetables are rich in fiber, but they also contain a high amount of micronutrients important, above all, in phases of rapid growth. Fruit and vegetables also appear to have an advantage over other **fiber-rich foods**–and are therefore **recommended in the diets of children**, e.g., **whole grains** and **legumes**–because, unlike the latter, they do not contain elements (phytates) which can reduce absorption of zinc and iron ingested through foods.

Fiber have a number of positive effects on the health of children, from the earliest years of life.

In terms of carbohydrates consumed in the diet, and excluding special cases of excessive consumption, the following can be stated:

- **no evidence exists of a connection between carbohydrate-rich diets and obesity in pre-school- and school-age children**;
- **a diet rich in starches and fiber** (i.e., rich in fruit and vegetables, whole grains and legumes), **has a determining role in creating an ideal diet, one that is complete, balanced and varied**.

Recommended amount of carbohydrates to be consumed in the diet (% total calories)

Age of child	Country/Organization		
	Italy	WHO	USA
age 1-3	55	55	45-65
age 4-6	55	55	45-65
age 7-10	55	55	45-65

Alongside the main macronutrients, other essential elements in a proper diet for pre-school- and school-age children are **vitamins** and **minerals**.

In small children, an adequate supply of **vitamin A** is necessary for correct development of vision, to guarantee the integrity of epithelial tissue and development of tissue differentiation. It also plays a central role in the correct development of the immune system and is involved in the development of taste and hearing.

The principal sources of vitamin A are: **liver, dairy products, eggs, fish, margarine** and certain types of **fruit and vegetables** (for example, carrots and yellow/orange colored fruit).

Prolonged lack of vitamin A can lead to the appearance of xerophtalmia and related **problems of blindness**. These disorders are almost completely absent in developed countries, where the lack of this vitamin in the child population is rarely so serious, while it is a grave problem in developing countries. In general, a slight lack of vitamin A is connected with an **increase in the tendency to contract infections** and has been identified as a factor in **contributing to the appearance of anemia** (in children). Excessive consumption of vitamin A also has negative effects on bones and liver functioning.

Because of its importance in certain crucial aspects of development in children of pre-school- and school-age, and given the potential risks connected with its prolonged lack, an **adequate supply of vitamin A is recommended, especially through regular consumption of fruit, vegetables and fish**.

Recommended amount of vitamin A to be consumed in the diet (grams/day)

Age of child	Country/Organization		
	Italy	WHO	USA
age 1-3	400	400	300
age 4-6	400	450	400
age 7-10	500	500	500

Like vitamin A, **B vitamins** play a fundamental role in the growth of children, as well as their correct sustenance and development. Specifically:

- **vitamin B1** (found above all in whole grains, legumes, peanuts and meat) plays an important role in **metabolizing carbohydrates**;
- **vitamin B2** (found primarily in leafy green vegetables, meat, eggs and milk) plays an essential role in maintaining correct **functioning of the nervous system**, **metabolizing protein** and in **child growth** (significant, prolonged shortage of this vitamin can cause growth retardation);
- **vitamin B3** (found primarily in whole grains, peanuts, legumes, meat, poultry and fish) plays a fundamental role in **metabolism** redox reactions and is essential to regulating **functioning of the nervous system**;
- **vitamin B12** (found above all in meat, eggs, fish, poultry and milk) is involved in **metabolism of fatty acids, amino acids** and **nucleic acids**, and a shortage of it can lead to disorders involving the **nervous system** and **production of blood cells**;
- although its role is still not known in detail, **folic acid** (or vitamin B9) is essential in the **synthesis of DNA and proteins** and in **hemoglobin formation**. It also plays a fundamental role in the **neuronal development** of children. Prolonged shortage of this vitamin could lead to the onset of megaloblastic anemia[16]. Folic acid is found primarily in yeast, liver, leafy green lettuce and oranges.

15 Amount of energy per unit of macronutrient consumed (in this case, Kcal/gram of fiber).

16 A serious form of anemia characterized by a gradual reduction in blood cells following failure of bone marrow to produce mature red blood cells.

Recommended amount of vitamin B in the diet

	Age of child	Country/Organization		
		Italy	WHO	USA
B1 (mg/day)	**age 1-3**	0.6	0.5	0.5
	age 4-6	0.7	0.6	0.6
	age 7-10	0.9	0.9	0.75
B2 (mg/day)	**age 1-3**	0.8	0.5	0.5
	age 4-6	1.0	0.6	0.6
	age 7-10	1.2	0.9	0.75
B3 (mg Niacina Equivalenti/day)	**age 1-3**	9	6	6
	age 4-6	11	8	8
	age 7-10	13	12	10
B12 (µg/day)	**age 1-3i**	0.7	0.9	0.9
	age 4-6	1	1.2	1.2
	age 7-10	1.4	1.8	1.5
Folic Acid (Italy: µg/day; WHO/USA: µg DFE/day)	**age 1-3**	100	160	150
	age 4-6	130	200	200
	age 7-10	150	300	250

Vitamin C is key to optimum **functioning of the immune system** and for **collagen synthesis**. In addition, vitamin C contains **antioxidant properties**, plays a significant support role in the process of **iron absorption** (especially from vegetable sources) and is essential in the prevention of scurvy (a disease which, it should be stressed, is not very common and appears only following prolonged periods of serious shortage of fruit and vegetables within the diet, which also occur together with a significant limit in overall food consumption).

Vitamin C is found primarily in **fruits** and **vegetables**, in particular in spinach, tomatoes, potatoes, broccoli, berries and citrus fruit.

Given the importance of an adequate intake of vitamin C, the WHO believes that **a child's diet must include a wide variety of raw and lightly-cooked vegetables** (long cooking times significantly reduce the amount of vitamin C in these foods).

Recommended amount of vitamin C in the diet (mg/day)

Age of child	Country/Organization		
	Italy	WHO	USA
age 1-3	40	30	15
age 4-6	45	30	25
age 7-10	45	35	35

Vitamin D plays an essential role in **metabolizing calcium** (stimulating its absorption in the intestine), **muscle functioning**, **cell proliferation and maturation** and correct **functioning of the immune system**.

The primary sources of vitamin D are **fatty fish** (sardines, salmon, tuna, herring, etc.), **fish oils** (especially cod liver oil), margarine, **dairy products**, **eggs**, **liver** and **beef**.

However, diet is not the main source through which vitamin D is accumulated in the human body: **the majority of this vitamin originates in the exposure of skin to the sun**. For this reason, pre-school- and school-age children living in the hottest areas of the planet generally have an adequate supply of vitamin D, irrespective of the specific composition of their diet. The greatest problems are seen in children who–for a number of reasons–are not able to enjoy adequate skin exposure to the sun's rays during the year (due to geography, inability to move, etc.).

Prolonged and significant levels of vitamin D deficiency in a growing child can cause **rickets** (with a reduced level of calcification in newly-formed bony parts).

Apart from extreme cases, shortages in vitamin D can be solved through **30 minute daily exposure to the sun's rays** (this is one of the reasons behind the recommendation that children be involved in regular outdoor activity, especially during the growth years). A significant excess of vitamin D can lead to hypercalcemia which is linked to growth retardation, anorexia and risk of calcification of soft tissues.

Recommended amount of vitamin D in the diet (µ/day)

Age of child	Country/Organization		
	Italy	WHO	USA
age 1-3	10	5	5
age 4-6	0-10	5	5
age 7-10	0-10	5	5

Alongside macronutrients and vitamins, the other essential elements in the diet of pre-school- and school-age children are **minerals**, specifically **iron**, **calcium magnesium phosphorus**, **sodium**, **zinc** and **iodine**.

Iron seems to be especially important for child health: **iron deficiency is very common**–especially in pre-school children, where its incidence level is approx. 40% worldwide, according to the WHO–and can vary from light to serious forms, in the latter case with significant consequences such as anemia and mental and motor development disorders.

The primary consequences of anemia caused by iron deficiency are:

- increased risk of **growth retardation**;
- increased risk of **exposure to infection** (there is evidence of the fact that a deficit of iron in the body can reduce immune defenses);
- **slowing/impediment of correct mental and psycho-motor development**.

Of all these, the potential connection between a lack of iron and damage to mental and motor development appears the most serious and worrying. Given the elevated amounts required for high growth rates, **pre-school- and school-age children are especially vulnerable** to possible, significant reductions in the presence of iron. Nonetheless, this period coincides exactly with the last phase in brain growth during which cognitive and psycho-motor development is completed.

Some studies have shown the existence of a relationship between iron deficit and limited mental and physical performance in children, especially in pre-school age. In addition, it has been suggested that lack of iron has an influence on the behavioral characteristics of children, causing them to be more introverted, cautious and indecisive with greater difficulty in interacting with the environment around them, a circumstance which would also negatively impact on normal intellectual development. In children of pre-school age, lack of sufficient iron intake has been connected with increased learning difficulties, especially linked to attention deficit and problem-solving abilities.

Despite the fact that these results seem completely relevant, it should be noted that *as yet there is no certainty about a direct causal relationship between anemia caused by iron deficiency and retardation in neurological development*: many risk factors other than anemia could, in fact, contribute to generating/greatly amplifying the neurological retardation observed, as much as iron deficiency-caused anemia itself could (social, economic and psychological problems, or physical problems other than anemia alone).

Despite this, given the existence of a concrete possibility of the child developing disorders over the long-term (both in terms of growth and intellectual development) following conditions of significant iron deficiency in the body, **prevention of iron deficiency anemia is one of the main goals of a diet which aims at safeguarding the health of pre-school- and school-age children, both in the present and future**.

In this case, diet also plays a role which goes beyond that of guaranteeing consumption of foods that contain an adequate amount of iron. One of the unique characteristics of iron is the low percentage (approx. 10-15%) of the mineral absorbed by the human body, compared with the total amount ingested through diet. Since the body is not equipped with special mechanisms to expel any excess iron, **regulation of the overall presence of iron in the body occurs through regulation of the amount of the mineral actually absorbed**.

This aspect **makes diet of key importance**, due to the ability of many macro- and micro-nutrients to influence the capacity of the human body to absorb iron ingested through diet. In addition, the reserves of iron which children have from birth gradually begin to be depleted after the sixth month of life and can only be replaced/maintained through diet.

Iron is divided into hemoglobinic iron (found in hemoglobin and myoglobin of meat, liver and fish) and non-hemoglobinic iron: the former is much more easily absorbed by the body (up to 25% in the case of iron deriving from meat), but less present in the overall average of iron consumed through diet. In addition, absorption of hemoglobinic iron is much less influenced by the type of other nutrients consumed through diet, compared with that for non-hemoglobinic iron.

Among those nutrients which **facilitate absorption** of iron, **vitamin C** present in fresh fruit and vegetables is particularly important. On the contrary, **phytates** (present in grains, vegetables, seeds and peanuts) and **polyphenols** (found above all in tea, coffee, cocoa and numerous varieties of vegetables, herbs and spices), are the main elements capable of slowing iron absorption. It should be noted that some traditional forms of food preparation (e.g., fermentation, grinding, germination, soaking, toasting/roasting) noticeably reduce the level of phytates present in foods of vegetable origin. For this reason, **products derived from a fermentation process** (such as yoghurt) also have a beneficial effect on iron absorption.

From a nutritional standpoint, *meat* and *fish* have a positive effect on the iron level in the body: they are rich in hemoglobinic iron and also foster absorption of non-hemoglobinic iron in other foods eaten during the same meal. In particular, **liver** is rich in iron and other micronutrients, such as zinc and vitamins A, B and D.

Small quantities of meat are able to provide a significant contribution to the overall process of iron absorption/accumulation and, for this reason, it seems useful that they be introduced gradually into a child's diet from a very early age (from the age of six months).

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Thomas J. Abercrombie /National Geographic Image Collection

The primary sources of non-hemoglobinic iron in foods are **grains**, **legumes**, **beans**, **vegetables** and **fruit**. However, due to increased presence of phytates in grains, legumes are preferable in a diet for children as they are a relatively bio-available source of iron. In addition, leavened bread should be preferred over non-leavened because the iron in the former is more easily absorbed by the body.

The iron present in non-modified **cow's milk** is only scarcely absorbed by the intestine (also because of its low vitamin C content), as shown in numerous studies which have indicated the negative effect of cow's milk on the level of iron in the child's body, especially in the first year of life. For this reason, the WHO suggests that cow's milk be introduced gradually and that its use be avoided during the first phases of life.

Fresh-squeezed juices, especially those with **fruit pulp**, have a high content of vitamin C which, as has been seen, has a positive effect on a child's ability to absorb iron, especially if drunk with meals. Fruit jams and preserves do not provide any benefit in terms of iron absorption since most of the vitamin C contained in the fruit is destroyed during the jam-making process.

In general, despite the importance of iron during growth for development of the body and formation of new tissue, **it is difficult to set common guidelines between countries and organizations for the recommended amount of iron** to be taken as part of the daily diet for two main reasons: on one side, there is still **relative uncertainty on a medical-scientific level** about optimal levels for pre-school- and school-age children, and on the other, **different dietary traditions/cultures** and differences in the nutritional sources of iron available in various areas of the world.

Recommended amount of iron in the diet (mg/day)

Age of child	Country/Organization		
	Italy	WHO	USA
age 1-3	7	6	7
age 4-6	9	6	10
age 7-10	9	9	9

In addition to iron, another essential mineral in a child's diet is **calcium**, essential to the **structural integrity** and **mineralization of bones and teeth** in children.

Calcium plays a role that is not secondary in numerous **metabolic** and **intracellular processes** and is one of the fundamental co-factors in many enzymes required for the functioning of the **nervous** and **muscular systems**.

Milk and **dairy products** are the main food source of calcium (and the best quality ones in terms of absorption). **Peanuts** and **fish** are other useful food sources in order to guarantee children an adequate level of this mineral.

Only rarely, especially in developed countries, are cases of significant calcium deficiency in children seen. In those cases which do exist, rickets develop, followed by growth retardation. Similarly, hypercalcemia (high levels of calcium in the blood) are very rare and lead to a state of light mental confusion, increase in irritability, loss of appetite and weakness.

Recommended amount of calcium in the diet (mg/day)

Age of child	Country/Organization		
	Italy	WHO	USA
age 1-3	800	500	500
age 4-6	800	600	800
age 7-10	1000	700	1050

A mineral essential to cell metabolism is **sodium**, fundamental, in particular, in **controlling extra-cellular volume** and **acid-base balance** in **cell electrical activity**, **nerve conduction** and **muscle functioning**.

The amount of sodium naturally present in foods (primarily meat, fish, eggs and milk) is very low and, therefore, **most salt ingested through diet is introduced by the**

salt utilized in preparing foods and/or added at the table. In diets characterized by elevated use of foods that have been highly-processed before preparation in the home, according to WHO estimates, almost 80% of the salt is added during preparation. Foods with particularly high amounts of sodium include: **sausage**, **bread**, **ham**, **condiments** and **pickled foods**.

Except under pathological conditions (e.g., gastroenteritis), cases of salt insufficiency in children (who are able to retain a sufficient quantity through regulation of urinary excretion) are unusual. Conversely, significant and prolonged over-consumption is possible and can have serious long-term consequences. In fact, it has been suggested that there is a causal relationship between excessive levels of salt in the diet of pre-school- and school-age children and the development of high blood pressure in subsequent years and in adulthood.

In light of this, **for pre-school- and school-age children, a diet in which overall sodium levels are low is recommended**. For this, in everyday life, salt should not be added during meal preparation and excessive consumption of salt-rich foods (pickled foods, cured meats, etc.) should be avoided.

Recommende amount of sodium in the diet (g/day)

Age of child	Country/Organization		
	Italy	WHO	USA
age 1-3	-	-	1.0
age 4-6	-	-	1.2
age 7-10	-	-	1.35

Zinc–a constituent element in many enzymes in the human body–plays an essential role in a wide range of **metabolic processes**, including protein and nucleic acid synthesis.

Zinc is found primarily in **red meat**, **liver**, **fish**, **milk** and **dairy products**, **wheat** and **rice**. As with iron, the level of absorption of zinc consumed in foods depends on the characteristics of the overall diet.
The zinc present in foods of animal origin is more easily absorbed compared with that present in foods of vegetable origin (vegetables, grains, etc.). In addition, whole grains and legumes are rich in phytates which reduce this mineral's absorption by the body. Absorption can also be limited by the intake of phosphates and calcium. On the other hand, some elements present in the diet–such as amino acids, lactose and iron (at levels which are not excessive)–improve zinc absorption.

A lack of zinc in the diet is normally caused by inadequate consumption of foods of animal origin (from this standpoint, some diets strongly/exclusively oriented towards consumption of vegetable products could be a source of zinc deficiency in children) **or by a diet characterized by high consumption of phytate-rich foods**. Aside from cases of particularly severe deficit, a moderately low level of zinc in the bodies of children could lead to a growth rate lower than that expected for the corresponding age bracket, and lower resistance of the immune system to infection.

In developing countries and, in general, in situations where growth is especially

compromised, a zinc supplement would appear useful; in similar cases this has been shown to have a positive impact on growth in pre-school- and school-age children[17].

Excessive intake of zinc in the diet does not seem to be common.

Recommended amount of zinc in the diet (mg/day)

Age of child	Country/Organization		
	Italy	WHO	USA
age 1-3	4	4.1	3
age 4-6	6	5.1	5
age 7-10	7	5.6	6.5

Two other minerals important for growing children are **magnesium** and **phosphorus**.

Magnesium is found primarily in roasted peanuts, nuts, raw spinach and certain types of leafy green vegetables; its availability is severely reduced by cooking foods.

It plays an important roles in numerous **metabolic processes**: in **muscular activity** (transmission of muscle impulses) and **functioning of the nervous system** (nerve transmission and electrical stability). In addition, it is also fundamental to a number of enzymatic reactions.

Approx. 50% of the magnesium present in the human body is immobilized within the skeleton, while the rest is traceable to cell liquids. **Magnesium plays a co-factor role in close to three-hundred enzymatic reactions required for metabolism of the entire body**.

Irregardless of age, an insufficient level of magnesium would appear correlated to an increase in the risk of ischemic cardiopathy, high blood pressure, osteoporosis, glucose intolerance and heart attack.

Recommended amount of magnesium in the diet (mg/day)

Age of child	Country/Organization		
	Italy	WHO	USA
age 1-3	-	60	80
age 4-6	-	73	130
age 7-10	-	100	185

Phosphorus–found primarily in milk, cheese, shrimp, salmon, sardines, herring and leafy green vegetables–is important for **bone metabolism**.

17 *In this regard, see, in particular, the WHO document entitled "Complementary feeding of young children in developing countries: a review of current scientific knowledge", Geneva, 1998*

Phosphorus is indispensable in numerous **metabolic processes** (fat, carbohydrate and protein metabolism) and stimulates muscle contraction. In addition, phosphorus also plays a significant role in intracellular mediation, electrical activity of the nervous system (impulse transmission) and kidney functioning.

Although uncommon, a significant and prolonged deficit in phosphorus and insufficient assumption of this mineral could cause a slowing in growth, the onset of osteoporosis, changes in the electrical conduction of the nervous system and weakness.

Recommended amount of phosphorus in the diet (mg/day)

Age of child	Country/Organization		
	Italia	OMS	USA
age 1-3	800	-	460
age 4-6	800	-	500
age 7-10	1000	-	875

2.4 Relationship between diet and health in adolescents: relationships and principles

Adolescence represents that period of life in which the passage from pre-puberty to adulthood takes place and it is characterized by important changes on a physical, psychic and social level.

Adolescence can be divided into two phases: early and late adolescence. Early adolescence corresponds to puberty, during which the body develops and completes its reproductive capacity (in general, between the ages of 10 and 15), while late adolescence is the period in which psychic/physical development is completed (generally between the ages of 15 and 18-22).

Adolescence is a period of intense metabolic activity[18]. In fact, during these years there is a major acceleration in growth in both males and females.

In this phase, somatic growth is accompanied by rapid psychological and behavioral development which leads the boy/girl to feel a progressively more intense need for independence and freedom; this also has a significant impact on eating habits.

The major physical changes tied to rapid growth and modifications caused by puberty are accompanied by both a quantitative and qualitative increase in nutritional needs (carbohydrates, proteins, fats), vitamins, minerals, fiber and water.

During adolescence, the daily amount of foods must be sufficiently rich to satisfy the increased request from growth processes, but also required is preventive action against metabolic-degenerative pathologies characteristic of adulthood: high blood pressure, diabetes, atherosclerosis and tumors.

18 Specifically, the prevalent part is anabolism or biosynthesis, i.e., that part of metabolism which includes all synthesis processes of more complex organic molecules from simpler ones or from nutritive substances. In other words, during adolescence, complex molecules are produced from simpler ones useful to the cell. These processes require energy and, specifically, anabolism is responsible for the formation of cell components and body tissue–therefore, for the growth of the individual.

Nutrition and issues tied to the adoption of a correct diet and lifestyle have a fundamental role during adolescence. During these years when psycho-physical development is completed, the bases are laid for correct eating habits which will play a preventive role for many pathologies in successive phases.

In fact, a diet which meets actual requirements contributes to preventing diseases which could arrive both in the short- and long-term, while an improper diet–whether too much or too little–fosters their onset.

These include:

- obesity and related complications;
- anorexia and bulimia which have their peak incidence during adolescence;
- osteoporosis, due to poor bone mineralization;
- high blood pressure, encouraged by consuming high levels of salt with foods;
- potential acceleration of atherosclerosis lesions, which can even be found in young people.

Despite the fact that adolescent diet is an issue of tremendous interest, very few studies have analyzed the nutritional requirements of this particular age bracket. Often, in fact, the data published in the various studies cited by national and international bodies are extrapolated from studies conducted on childhood and adulthood.

During these years when psycho-physical development is completed, the bases are laid for correct eating habits which will play a preventive role for many pathologies in successive phases.

In the absence of in-depth and sufficiently broad-ranging studies (both in terms of the sample size used and the time frame) involving energy needs during adolescence, it is difficult to establish the needs of an individual with rapid swings in his or her rhythm of growth from one year to the next and significant diversity between individuals and the two sexes.

The following table provides the energy requirements for the various age brackets during adolescence.

Energy requirements for males and females during adolescence

	Age	Males	Females
Energy requirement (kcal/day)	11/12	1993-2343	1739-2048
	13/14	2277-2794	1864-2297
	15/16	2393-2976	1898-2338
	17/22	2515-3215	1942-2411

Source: TEH-Ambrosetti elaboration based on data from the Società Italiana di Nutrizione Umana, Associazione italiane di dietetica e nutrizione clinica; Giovannini M, European Journal Clinical Nutrition 54, 2000

These ranges are strongly influenced by various factors including weight, physical make-up and level of physical activity.

In most cases, the energy requirement is efficiently met through fine-tuned, automatic regulation of appetite by the hypothalamus. Appetite promotes consumption of food which responds both to energy needs and those of the various nutrients. Generally, this system works quite well in guaranteeing that an amount of energy sufficient to meet metabolic requirements is consumed. The same cannot be said of regulation of the intake of nutrients which might not be optimal, leading to potential shortages in certain elements.

The nutritional requirements of adolescents are influenced, first and foremost, by the physical growth of the individual. Growth generally peaks between the ages of 11 and 15 in girls, and between 13 and 16 in boys. In addition, the energy and nutrient requirements can vary from day to day, even in the same person.

The most common deficiencies in nutrients at this age are those of iron and calcium.

Anemia caused by iron deficiency is one of the most common diseases associated with food-related deficits[19]. Adolescents can be subject to iron deficiency anemia due to increased tissue needs, in particular in muscle and erythrocyte mass which involves a significant increase in iron to produce hemoglobin (protein which transports oxygen) and myoglobin (globular protein contained in muscle).

The increment in lean body mass[20], especially muscles, pertains more to male adolescents than females. In pre-adolescence, lean body mass is approximately equal in the two sexes, but with the onset of adolescence, males experience greater accumulation of lean body mass for each additional kilogram of body weight gained during growth, which will lead to a final lean body mass almost double that in females.

Another factor which contributes to increasing the iron requirement is the start of the menstrual cycle in girls. Menstrual blood flow causes a constant loss of this fundamental trace element which must be reintegrated into the body by increasing its consumption during those days.

It is important, therefore, that during adolescence, the consumption of iron-rich foods be increased[21], for example:
- lean meats and fish;
- legumes;
- dark green vegetables;
- walnuts;
- iron-enriched grains.

In any case, it is recommended that adolescents, and above all adolescent girls, be tested periodically for levels of iron in the blood. In the event of low levels, the doctor will decide if further testing or any iron supplements are required.

Iron requirement in adolescents

Males	12 mg per day
Females (age 11-12 to the first menstruation)	12 mg per day
Females (from the first menstruation throughout the fertile years)	18 mg per day

Source: TEH - Ambrosetti elaboration of data from the Società Italiana di Nutrizione Umana and other studie

19 American Academy of Pediatrics. Committee on Nutrition, Iron fortification of infant formulas, Pediatrics, 1999.
20 Lean Body Mass is what remains of the body after stored fat has been removed.
21 Wardley, B. L.; Puntis, J. W. L.; Taitz, L. S., Handbook of Child Nutrition. 2nd ed. Oxford University Press, Oxford, 1997; James, J., Iron deficiency in toddlers. Maternal and Child Health, 1991; Walter, T., Dallman, P.R., Pizarro, F., Velozo, L., Pena, G., Bartholmey, S.J., Hertrampf, E., Olivares, M., Letelier, A., Arredondo, M., Effectiveness of iron-fortified infant cereal in the prevention of iron deficiency anaemia. Pediatrics, 91(5):976-982, 1993.

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Once they have begun menstruating, girls must introduce a greater amount of iron than boys by a good 50%, to an equivalent of 18 mg per day compared with 12 mg per day in boys.

The iron contained in foods is not absorbed in the same quantity. In fact, iron of animal origin (also called "eme iron") is absorbed better than that from non-animal sources (also known as "non-eme iron").

Therefore, adolescents who follow a vegetarian diet are at greater risk of iron deficiency. However, consuming vitamin C-rich foods (found in citrus fruit) fosters absorption of iron from vegetable sources.

Calcium also has an essential function in the rapidly-growing adolescent body because it is part of the composition of bone and teeth.

The human skeleton houses approx. 99% of the body's total calcium reserves and the increase in the size and weight of the skeleton reaches its high point during adolescence.

Approx. 45% of the skeletal mass in adults is formed during adolescence, even if the skeleton continues to grow until almost the age of 30. Clearly, lack of calcium during this

period can damage proper growth in individuals. More specifically, the enhanced need for calcium is seen in what is called "early adolescence", i.e., between 10 and 14 in girls and 12 and 15 in boys. During this period, the average daily retention of calcium is approx. 200 mg in females and 300 mg in males.

Since the efficiency of calcium absorption is only about 30%, it is fundamental that diet during adolescence supply an adequate amount of calcium in order to attain the greatest bone density possible.

It is only during adolescence that the body can deposit in growing bone tissue the maximum amount of calcium possible to attain so-called "peak bone mass", the maximum calcification possible.

The maximum quantity of calcium that can be deposited in the bones is determined genetically, but peak bone mass can never be reached if the individual does not consume a sufficient amount of calcium in the diet.

From this it can be seen how important it is to eat foods rich in calcium, not only for boys, but especially, for girls who in later years with the onset of menopause will be at greater risk of osteoporosis. Regarding this, as can be seen from the results of a number of studies,[22] reaching "peak bone mass" in adolescence is crucial for reducing the risk of osteoporosis in subsequent years.

On the other hand, it is very common for adolescents to follow eating habits lacking in a number of nutrients, either based on what is in fashion or the desire to lose too much weight too quickly. Osteoporosis represents one of the most serious and potentially irreversible consequences of anorexia nervosa and rapid, excessive weight-loss in adolescent girls who, as a result, do not reach their "peak bone mass".

Calcium requirement in adolescents

Males	1200 mg per day
Females	1200 mg per day

Source: TEH - Ambrosetti elaboration of data from the Società Italiana di Nutrizione Umana and other studies

For adolescents of both sexes, it is recommended that 1200 mg of calcium be consumed each day. Dairy products represent the primary food source for calcium.

For example:
- 250 ml of milk supplies approx. 310 mg of calcium;
- 125 grams of yoghurt (an individual container) supplies approx. 150 mg of calcium;
- 100 grams of parmesan cheese contains approx. 1150 mg of calcium;
- 100 grams of crescenza/stracchino soft cheese contains approx. 560 mg of calcium;
- 100 grams of emmenthal cheese contains approx. 1140 mg of calcium;
- 100 grams of mozzarella cheese contains approx. 160 mg of calcium.

Aged cheeses produced using a process in which water content is extracted, contain higher concentrations of calcium.

22 Weaver, C. M., The growing years and prevention of osteoporosis in later life. Proceedings of the Nutrition Society, 59:303-113, 2000.

Therefore, consuming different proportions of dairy products such as milk, yoghurt, mozzarella and other cheeses, the recommended level of calcium consumption can easily be met.

To grow, bones and the skeleton require other minerals and vitamins than calcium, such as phosphorus and vitamin D.

In addition to growth of muscle tissue and the skeleton which requires energy and specific nutrients which must sometimes be integrated specifically, other factors such as stress and emotional anxiety typical of the adolescent years can negatively impact on the nutritional equilibrium of teenagers, resulting in insufficient or excessive food consumption.

In addition, infections, emotional tension, menstruation and teeth or skin problems (such as acne) can have an influence on appetite and increase the vulnerability of adolescents whose diet must be such as to properly meet the caloric demands of their bodies (e.g., ca. 2500-3000 calories per day for boys).

Emotional stress is often associated with food fads and weight-loss trends, especially in girls, both of which can lead to a relationship with food that is not serene and balanced.

On the other hand, overweight and obesity in adolescents constitute a serious nutritional problem that tends, with high probability, to carry over into adult life. A study conducted on a European-wide level[23] showed that obesity has sharply risen in recent years. Obesity in adolescence is connected with metabolic diseases and in adulthood with higher mortality rates. But beyond the physical aspects, risks connected with obesity also affect psycho-social ones.

Other factors such as stress and emotional anxiety typical of the adolescent years can negatively impact on the nutritional equilibrium of teenagers, resulting in insufficient or excessive food consumption.

Adolescents are, in fact, particularly aware of their own body image and excessive weight can have a profound impact on emotional well-being and physical health, as was shown in a recent study[24] in which among the causes of obesity were not only social-economic, biochemical and genetic factors, but also psychologically-related aspects.

Anorexia and bulimia nervosa, as well as compulsive eating binges, are the most common food disorders affecting adolescents.

Anorexia nervosa is characterized by:
- refusal to maintain body weight above the normal minimum weight by age and height;
- intense fear of gaining weight or becoming fat, even when the individual is actually underweight;
- change in the way the adolescent experiences his/her weight or figure, or excessive influence of weight and figure on levels of self-esteem, or refusal to admit the severity of the actual situation of underweight;
- amenorrhoea in girls, i.e., skipping of a least three consecutive menstrual cycles.

23 International Life Sciences Institute, Overweight and Obesity in European Children and Adolescents. Causes and consequences-prevention and treatment. pp. 1-22. ILSI Europe, Brussels, Belgium, 2000.
24 M. Wabitsch, J. Hebebrand, W. Kiess, K. Zwiauer, Child and Adolescent Obesity: Causes and Consequences, Prevention and Management, Springer, 2004.

In terms of this last point, from recent studies[25] it has emerged that one year after skipped menstruations in anorexics (amenorrhoea), the loss in bone mass is significant, rapid and sufficient to justify fractures in vertebrae, the sternum and long bones.

Bulimia nervosa, on the other hand, is characterized by recurrent binges with the following characteristics:

- eating over a specific time period, for example two hours, an amount of food significantly greater than what others of the same age would eat during the same period of time and under similar circumstances;
- sense of losing control during the binge, for example, the sensation of not being able to stop eating or controlling what and how much is being eaten.

The episodes of uncontrolled ("binge") eating are associated with the following symptoms:

- eating much faster than normal;
- eating until feeling unpleasantly full;

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- eating large amounts of food even if one does not feel physically hungry;
- eating alone out of embarrassment about how much one is eating;
- feeling disgusted about oneself, depressed or very guilty following bulimic crises.

On the average, binge-eating occurs at least two days a week over a six-month period.

In terms of anorexia and bulimia nervosa, there is no precise data because epidemiological studies have shown that only a minority of clinical cases, irrespective of their seriousness, are recognized and sent to therapeutic centers.

Despite this, it can be noted that the clinical syndromes of eating disorders have increased, especially in the west and that they cut across all social classes, although remaining highest among females. In fact, between 90% and 95% of the cases of this disorder affect young girls between 12 and 18, although cases can occur after 25 years of age. In Italy, anorexia and bulimia affect between 8% and 9% of adolescent girls[26] in a more limited way and 1% in a more severe form.

There are many complications caused both by the state of malnutrition and pathological behavior used to reach this state. Some complications, such as the endocrine-related ones are, in reality, affected by systems of adapting to fasting instituted by the adolescent's body in order to survive the critical period. The most frequent medical complications that may arise are:

- cardiovascular;
- pulmonary;
- endocrine-metabolic;
- hematologic;
- gastrointestinal;
- neurologic.

Eating disorders are prevalently generated by psychiatric disorders and, as was shown in a recent study conducted by the Società Italiana di Psichiatria, more than half of adolescents consider themselves to be overweight and have attempted at least once to diet during adolescence.

Within this context, both anorexia and bulimia nervosa have a prognosis of full recovery that ranges from five to ten years and, in half of the cases, the mortality rate of adolescents with eating disorders is one of the highest among psychiatric disorders.

In addition to a healthy and correct diet, the health of adolescents is also associated with physical movement.

Motor activity contributes to burning calories, release tension and stress, and improve humor and psychological well-being. Regular physical activity and sports significantly benefit the cardiovascular and skeletal system, as well as metabolism. Regular motor activity fosters the maintenance of proper body weight and fitness, makes adolescents stronger and accustoms them to adopting a lifestyle that will make them healthier in the years to come.

In this light, lack of physical activity in adolescents plays an important role in the development, progression and perpetuation of a number of illnesses, such as obesity. Studies performed in Europe and the US have shown that the majority of adolescents are physically inactive or adopt a lifestyle that does not include adequate physical activity: in other words, they are sedentary.

Lack of physical activity is not only one of the main causes of overweight and obesity, but also the development, in later years of life, of chronic pathologies such as cardiac disease, diabetes, high blood pressure, constipation and intestinal diverticulitis, osteoporosis and some forms of cancer.

26 Data published by the Centro Nazionale di Epidemiologia, Sorveglianza e Promozione della Salute in 2008.

Justin Guariglia/National Geographic Image Collection

Sports and motor activity such as swimming, gymnastics, cycling, etc., or even more simply bike riding, skating, ball games, dance and weight-lifting supervised by an instructor, for approx. 60 minutes per day, 3 to 5 times per week, can contribute to increasing bone mass and density. What's more, proper physical activity has a positive impact on improving the body's flexibility, balance, agility and coordination, while also strengthening bones.

Based on current recommendations[27], adolescents should be physically active for at least 60 minutes per day, which includes both sports and recreation.

But to grow in a healthy, correct way, adolescents must not only engage in proper physical activity, they must also eat properly. Specifically, eating properly means taking into consideration:

- how much food is consumed;
- the quality of the foods eaten as part of one's diet;
- how food is distributed throughout the day.

27 United States Department of Agriculture, Center for Nutrition Policy and Promotion, 2006.

Calorie levels, analyzed in Figure 1, should be broken down as follows: breakfast 20%; mid-morning snack 5%; lunch 35%; afternoon snack 10%; supper 30%.

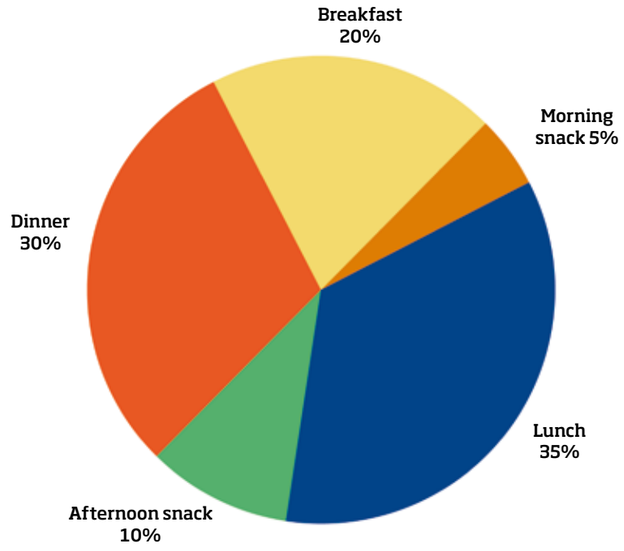
In adolescence, breakfast is a key moment in that the body, following a night's rest, requires energy to resume activity. Often this moment is ignored by adolescents who pay little attention to breakfast. In actuality, breakfast should include foods such as milk, bread, melba toast, yoghurt, cereal, fruit and honey. This will allow adolescents to be in form for their school work during the morning and not be too hungry at lunch time.

During the day, snacks can help provide adolescents with the energy and nutrients they require, but these must also be varied (fruit, cookies, chocolate, etc.) and not too abundant in order to not ruin their appetites at meals.

During main meals, the diet must be varied and amounts not excessive. Having a varied diet is the best way to assure the adolescent's growing body a supply of all necessary nutrients, such as calcium and iron.

Dietary habits centered around a single diet and repeated, frequent consumption of lunch/supper away from home (for example, in fast food restaurants) significantly increases the risk of overweight and obesity in adolescents[28].

Figure 6. Recommended breakdown of the caloric intake during the day



Source: TEH - Ambrosetti elaboration of data from the Società Italiana di Nutrizione Umana

28 Sarah E. Barlow, Expert Committee Recommendations Regarding the Prevention, Assessment, and treatment of Child and Adolescent Overweight and Obesity: Summary Report, Pediatrics, 2007.

Variety means a mixed diet which includes foods of vegetable origin (fruit, vegetables, legumes, grains, seeds, etc.) and animal origin (meat, cheese, dairy products, ham, etc.), as well as a rotation of foods during the week.

As in adulthood, for adolescents, the principle of variety is extremely important. Specifically, the diet of an adolescent should include:

- grains (bread and pasta) every day;
- fruit and vegetables every day;
- milk and dairy products every day;
- meat 2-3 times per week;
- fish at least three times per week;
- cheese twice a week;
- eggs twice a week;
- legumes at least twice a week.

A varied diet will easily provide the nutrients an adolescent requires for growth.

Recommended breakdown of the caloric intake during the day

Food	Nutrients required by adolescents
Grains	Carbohydrates, B-group vitamins (vitamin B1, B2, niacin, B6), fiber
Legumes	Protein, vitamin B1, vitamin B6, niacin, pholates, iron, zinc, calcium
Vegetables	Fiber, potassium, calcium, iron (especially in spinach), zinc, vitamin C, folic acid, vitamin K, carotenoids, phenolic compounds and flavonoids
Fresh fruit	Vitamin C (especially in citrus fruit, kiwi and strawberries), carotenoids
Dried fruit	Protein, iron, zinc, selenium, calcium
Meat	Protein, B-group vitamins (including B12), iron, zinc, copper, selenium
Fish	Protein, vitamin A, vitamin D, long-chain polyunsaturated fatty acids; some types of salt-water fish and shellfish rich in sodium and fluorine
Eggs	Protein, B-group vitamins and pholates
Milk and dairy products	Protein, vitamins (riboflavin, retinol, carotenes), calcium, magnesium, phosphorus, zinc, selenium

Source: TEH-Ambrosetti elaboration

Given the importance of nutrition during adolescence, especially in the prevention of major chronic illnesses, governments and international organizations concerned with health-related issues have drawn up guidelines to define a balanced diet during various phases of human life, with special focus on adolescence.

Having to organize these recommendations into a summary table has resulted in some approximation given discrepancies in the data collected. A special effort regarding this was made by a number of national and international bodies which, rather than identifying an "optimum diet", analyzed the ideal quantity of nutrients an individual should consume daily as part of a correct diet.

The main references regarding nutrient consumption during the various phases of development/life of an individual have been published by:

- Società Italiana di Nutrizione Umana;
- Food and Nutrition Board (USA);
- WHO.

Nutrients and quantities recommended by the Società Italiana di Nutrizione Umana

Category (daily intake)	Age (yrs)	Wgt (Kg)	Protein (g)	Essential fatty acids (g)		Calcium (mg)	Phosphorus (mg)	Potassium (mg)	Iron (mg)	Zinc (mg)	Copper (mg)	Selenium (µg)
				w 6	*w 3*							
Males	11-14	35-53	44-65	5	1	1200	1200	3100	12	9	0.8	35
	15-17	55-66	64-72	6	1.5	1200	1200	3100	12	9	1	45
	18-29	65	62	6	1.5	1000	1000	3100	10	10	1.2	55
	30-59	65	62	6	1.5	800	800	3100	10	10	1.2	55
	60+	65	62	6	1.5	1000	1000	3100	10	10	1.2	55
Females	11-14	35-51	43-58	4	1	1200	1200	3100	12-18	9	0.8	35
	15-17	52-55	56-57	5	1	1200	1200	3100	18	7	1	45
	18-29	56	53	4,5	1	1000	1000	3100	18	7	1.2	55
	30-49	56	53	4,5	1	800	800	3100	18	7	1.2	55
	50+	56	53	4,5	1	1200-1500	1000	3100	10	7	1.2	55

Source: TEH - Ambrosetti elaboration of data from the Società Italiana di Nutrizione Umana

Nutrients and quantities recommended by the Società Italiana di Nutrizione Umana

Category (daily intake)	Age (yrs)	Wgt (Kg)	Iodine (µg)	Riboflavin (mg)	Niacin (mg)	Vit. B_6 (µg)	Vit. B_{12} (µg)	Vit. C (mg)	Pholates (µg)	Vit. A (µg)	Vit. D (µg)
Males	11-14	35-53	150	1.4	15	1.3	2	50	180	600	0-15
	15-17	55-66	150	1.6	18	1.5	2	60	200	700	0-15
	18-29	65	150	1.6	18	1.5	2	60	200	700	0-10
	30-59	65	150	1.6	18	1.5	2	60	200	700	0-10
	60+	65	150	1.6	18	1.5	2	60	200	700	10
Females	11-14	35-51	150	1.2	14	1.1	2	50	180	600	0-15
	15-17	52-55	150	1.3	14	1.1	2	60	200	600	0-15
	18-29	56	150	1.3	14	1.1	2	60	200	600	0-10
	30-49	56	150	1.3	14	1.1	2	60	200	600	0-10
	50+	56	150	1.3	14	1.1	2	60	200	600	10

Source: TEH - Ambrosetti elaboration of data from the Società Italiana di Nutrizione Umana

Nutrients and quantities recommended by the Food and Nutrition Board

	Age (yrs)	Vit. A (mg)	Vit. C (mg)	Vit. D (µg)	Vit. E (mg)	Riboflavin (mg)	Niacin (mg)	Vit. B_6 (mg)	Vit. B_{12} (mg)	Pholates (mg)	Biotin (mg)
Males	9-13	600	45	5	11	0.9	12	1.0	1.8	300	20
	14-18	900	75	5	15	1.3	16	1.3	2.4	400	25
	19-30	900	90	5	15	1.3	16	1.3	2.4	400	30
	31-50	900	90	5	15	1.3	16	1.3	2.4	400	30
	51-70	900	90	10	15	1.3	16	1.7	2.4	400	30
	70+	900	90	15	15	1.3	16	1.7	2.4	400	30
Females	9-13	600	45	5	11	0.9	12	1.0	1.8	300	20
	14-18	700	65	5	15	1.0	14	1.2	2.4	400	25
	19-30	700	75	5	15	1.1	14	1.3	2.4	400	30
	31-50	700	75	5	15	1.1	14	1.3	2.4	400	30
	51-70	700	75	10	15	1.1	14	1.5	2.4	400	30
	70+	700	75	15	15	1.1	14	1.5	2.4	400	30

Source: TEH-Ambrosetti elaboration of data from the Food and Nutrition Board

Nutrients and quantities recommended by the Food and Nutrition Board

	Age (yrs)	Calcium (mg)	Copper (µg)	Iron (mg)	Magnesium (mg)	Manganese (mg)	Phosphorus (mg)	Selenium (µg)	Zinc (mg)	Potassium (g)	Sodium (g)
Males	9-13	1300	700	8	240	1.9	1250	40	8	4.5	1.5
	14-18	1300	890	11	410	2.2	1250	55	11	4.7	1.5
	19-30	1000	900	8	400	2.3	700	55	11	4.7	1.5
	31-50	1000	900	8	420	2.3	700	55	11	4.7	1.5
	51-70	1200	900	8	420	2.3	700	55	11	4.7	1.3
	70+	1200	900	8	420	2.3	700	55	11	4.7	1.2
Females	9-13	1300	700	8	240	1.6	1250	40	8	4.5	1.5
	14-18	1300	890	15	360	1.6	1250	55	9	4.7	1.5
	19-30	1000	900	18	310	1.8	700	55	8	4.7	1.5
	31-50	1000	900	18	320	1.8	700	55	8	4.7	1.5
	51-70	1200	900	8	320	1.8	700	55	8	4.7	1.3
	70+	1200	900	8	320	1.8	700	55	8	4.7	1.2

Source: TEH-Ambrosetti elaboration of data from the Food and Nutrition Board

Lynn Johnson/National Geographic Image Collection

On a general level, the eating habits which have an influence on food preferences, and calorie and nutrient consumption are developed in early childhood and, in particular, during adolescence. For this reason, the home and school settings play an essential role in defining the adolescent's relationship with food and consumption of individual food products.

Analysis of a recent study carried out on eating habits of adolescents in Europe[29] has evidenced a number of interesting points for reflection.

29 *Janet Lambert, Carlo Agostoni, Ibrahim Elmadfa, Karin Hulshof, Edburga Krause, Barbara Livingstone, Piotr Socha, Daphne Pannemans and Sonia Samartin,* ***Dietary intake and nutritional status of children and adolescents in Europe****, British Journal of Nutrition, 92, 2004.*

Considering the differences in age, build, sex, etc., the data gathered show that daily caloric intake is basically the same among European adolescents. More specifically, during early adolescence, caloric intake is essentially the same between males and females, while in late adolescence, there begins to be a difference in caloric intake in favor of males. Again on a general level, among females, calorie levels begin to level out around the age of 15 and tend to decline after 18.

Within each group of adolescents divided by age, body weight, sex, etc., this study indicates a significant variation in daily calorie levels between adolescents in various countries. This variation reflects not only different body weights, but also erroneous eating habits found among European adolescents.

European males eat more carbohydrates and fiber compared with females, in terms of absolute amounts, but the percentage of calories from carbohydrates compared with total intake is similar between males and females.

The home and school settings play an essential role in defining the adolescent's relationship with food and consumption of individual food products.

On an overall level, intake of carbohydrates, sugars and saccharose is lower in southern European countries than in central-northern ones.

Adolescents living in Mediterranean countries have high consumption levels of monounsaturated fatty acids (contained, for example, in olive oil), while adolescents in central and eastern Europe were seen to consume more polyunsaturated fatty acids. Northern European countries showed the lowest intake of fatty acids, with the exception of Finland where the levels of fats were the highest in Europe.

In terms of protein levels, on the other hand, values were substantially similar, around 17% and 19% of total calories. In some countries, such as Austria, Germany, Holland and the United Kingdom, these values were between 11% and 15%.

Alcohol consumption increases across-the-board after 11 years of age, although within various groups of adolescents, very significant differences can be seen–for example, boys consume more alcohol than girls. These habits are bad and a risk to their health, both present and future.

In terms of vitamin levels, study results show that the highest consumption of B9 (folic acid) in Europe is in the United Kingdom. Greater consumption of vitamin D is seen in northern European countries, while the lowest levels are found in eastern European countries. A possible explanation for this could be the higher consumption of milk and dairy products by adolescents living in northern Europe. Higher intake levels of vitamin E are seen among adolescents in central and eastern Europe, which could be tied to greater consumption of polyunsaturated fatty acids.

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2.5 Dietary guidelines for children and adolescents

Guidelines for pre-school age children[30]

For pre-school- and school-age children–also given the lack of studies conducted to-date and the strong influence of the eating habits of each child's family–the various guidelines tend to overlap less and often (especially for the school-age bracket) are very similar to those for adolescents and adults, except, of course, for obvious differences in the amounts recommended.

In general, the distribution of overall calories in pre-school years should be close to the following:

- calories from protein: 10-15% of the total;
- calories from fats: 28-30% of the total;
- calories from carbohydrates: 55-60% of the total with overall caloric intake that is balanced and divided.

In terms of how meals are divided over the course of the day, it should be noted that nutritionists recommend that children should eat five times per day.

Vegetables should be consumed at both lunch and dinner. Similarly, fruit must be eaten each day, either at the end of a meal or as part of the mid-morning/afternoon snack; preferably, the fruit should be fresh.

Breakfast should be comprised of 15-20% of the day's total caloric intake: starting at age one, children can drink cow's milk accompanied by plain cookies or melba toast.

The mid-morning/afternoon snack (5-10% of total daily caloric intake) should always include fresh fruit and avoid regular consumption of packaged sweet and salty snacks. Especially recommended for the afternoon snack are milk, fruit shakes and yoghurt.

Lunch and supper should provide 30-40% of total daily caloric intake. Consumption of a varied range of foods during main meals should be aimed at providing a complete supply of macro- and micronutrients, as well as variation in the composition and flavors of foods. A recommended weekly breakdown could be:

- meat 3-4 times per week;
- legumes twice a week;
- Parma ham or boiled ham (fat removed) once a week;
- fish twice a week;
- cheese 3 times a week;
- eggs twice a week.

As a general rule, vegetables should be consumed at both lunch and dinner. Similarly, fruit must be eaten each day, either at the end of a meal or as part of the mid-morning/afternoon snack; preferably, the fruit should be fresh. Legumes should also be a regular part of the diet.

It is important that growing children be guaranteed the correct amount of foods containing basic minerals, in particular iron, zinc and calcium. From this standpoint, meat, milk and dairy products, grains, oats, flour, egg yolks and hard cheeses are foods which, to varying degrees, should be included in the diet during this growth phase, while always bearing in mind the guidelines in terms of the recommended amounts to be consumed and how often, as indicated above.

30 These guidelines were developed primarily using as a basis those proposed by the Unità Operativa Clinica - Dipartimento Medico Chirurgico di Epato-Gastroenterologia e Nutrizione dell'Ospedale Pediatrico Bambino Gesù in Rome.

Rich Reid/National Geographic Image Collection

In order to prevent the main risk factors of chronic diseases (obesity, diabetes, cardiovascular disease and cancer), from the earliest years of life it is essential that excessive use of the following be avoided:

- salt (directly or through highly-salted foods);
- calorie-rich foods;
- proteins and fats of animal origin.

In addition to strictly nutritionally-related recommendations, it should also be noted that regular physical activity (principally out-of-doors) is considered one of the fundamental factors in the health of pre-school-age children (as this also has important positive spin-offs in terms of reducing risks connected with the onset of principal chronic diseases in later years, including as an adult).

Guidelines for school-age children and adolescents[31]

To-date, there exists nothing in the literature[32] regarding a complete and valid reference for the energy needs of adolescents. As already indicated above, the recommendations available for energy and protein requirements were obtained indirectly and have been extrapolated from requirements for other age brackets. The same approach was also used to determine recommendations for macronutrient consumption.

Recommendations for fat and carbohydrate consumption in adolescent boys and girls

Fats	
Total fats	20 to 30% of total caloric intake
Saturated fatty acids	less than 10% of total caloric intake
Cholesterol	< 300 mg per day

Carbohydrates	
Total carbohydrates	55-60% of total caloric intake
Simple carbohydrates	10-12% of total caloric intake
Fiber	circa 30 mg per day

Source: Giovannini M et al. European Journal Clinical Nutrition 54, 2000.

In this situation, it can be seen that the level of fats and carbohydrates and their constituent qualities have been adapted to adult guidelines[33], above all for preventive reasons in order to prevent the onset of chronic diseases in subsequent years. In fact, as has been amply shown[34], the qualitative distribution of saturated and unsaturated fats and slow- and fast-absorbing carbohydrates would seem to have a predictive function in the development of cardiovascular disease and metabolic disorders contracted in adulthood.

The dietary recommendations that have been formulated are, therefore, aimed at increasing consumption of vegetables, fruits and legumes in adolescents, the goal being to create a better equilibrium in the relationship between energy and protein and between saturated and unsaturated fats, with an increase in the consumption of slow-absorbing carbohydrates and with an increase in fiber.

31 *These guidelines were developed primarily using as a basis those proposed by the Unità Operativa Clinica - Dipartimento Medico Chirurgico di Epato-Gastroenterologia e Nutrizione dell'Ospedale Pediatrico Bambino Gesù in Rome.*
32 *Gregory, J.; Lowe, S.; Bates, C. J., Prentice, A., Jackson, L. V., Smithers, G., Wenlock, R., Farron, M., National Diet and Nutrition Survey: young people aged 4-18 years, vol. 1. Report of the Diet and Nutrition Survey, TSO, 2000.*
33 *Synthesis based on studies by Hu, Mensink, Katan, Kris-Etherton Sundram, Anisah, Hayes, Jeyamalar, Pathmanathan, Hornstra, Houwelingen, Kester, Willett, Ascherio, Hennekens, Buring, Koletzko and Oomen, analyzed and published in 2009 as part of the study by the Barilla Center for Food and Nutrition, "Alimentazione e Salute".*
34 *Heart Disease and Stroke Statistics - 2009 Update, The American Heart Association Statistics Committee and Stroke Statistics Subcommittee, Circulation, 2008; Cardiovascular diseases, Fact sheet n° 317, February 2007, World Health Organization; European cardiovascular disease statistics 2008, British Heart Foundation; Health Promotion Research Group, Department of Public Health, University of Oxford; Health Economics Research Centre, Department of Public Health, University of Oxford, 2009; European cardiovascular disease statistics 2008, British Heart Foundation; Health Promotion Research Group, Department of Public Health, University of Oxford; Health Economics Research Centre, Department of Public Health, University of Oxford, 2009.*

Annie Griffiths Belt/National Geographic Image Collection

For breakfast, which must provide approx. 20% of the daily caloric requirement, the main recommendations are to consume:
- a cup of hot milk with barley coffee and bread (preferably whole grain) with jam or honey;
- a container of yoghurt with added fresh fruit and bread;
- a cup of milk or yoghurt with cereal and fresh fruit;
- a portion of seasonal fruit, a glass of fresh-squeezed citrus juice and bread.

As a mid-morning or afternoon snack, which should be, respectively, ca. 5% and 10% of daily caloric intake, it is recommended that fresh fruit should be consumed primarily, and with only moderate consumption of cold cut/cheese sandwiches that are rich in fats; excessive consumption of the latter will reduce the appetite for the main meal. The specific recommendation for an afternoon snack is fresh fruit or fruit milkshake, yoghurt with fresh fruit or sherbert.

For lunch and supper–respectively 35% and 30% of daily caloric intake–the main recommendations are to plan meals for the week and vary the dishes consumed as much as possible, bearing in mind that:
- first courses should be served every day at lunch and dinner, alternating pasta with soups between lunch and supper[35];

35 *These guidelines were developed primarily using as a basis those proposed by the Unità Operativa Clinica - Dipartimento Medico Chirurgico di Epato-Gastroenterologia e Nutrizione dell'Ospedale Pediatrico Bambino Gesù in Rome.*

- the main course should be comprised of meat or lean cured meats 2-3 times per week, fish 3-4 times per week, legumes, cheese and eggs twice per week.

Generally speaking, it is recommended that the evening meal include a puréed vegetable soup or broth if pasta was served at lunch, alternation of raw and cooked vegetables, with meat or fish dishes being avoided for the evening meal if these were already eaten midday.

It is recommended that vegetables be consumed both at lunch and dinner, and fruit at snack time.

In preparing meals for adolescents (although the same rules are also valid for adults), it should be stressed that the more the diet consists of "simple dishes" the easier it will be for the body to digest and transform food into energy.

Among energy-filled foods essential for adolescents, bread, pasta, rice, potatoes and corn provide glucides which are the primary source of energy. Sugar, honey, chocolate and jams, above all at breakfast, are among those energy-rich foods which supply energy that is immediately available. Dried and fresh legumes such as beans, lentils, chick peas, green peas, soyabean, etc., are protein-rich foods that are very important for growth because they provide high-quality protein, minerals (calcium, iron) and B-group vitamins.

It should be stressed that the more the diet consists of "simple dishes" the easier it will be for the body to digest and transform food into energy.

Other protein-rich foods include milk, dairy products, yoghurt and cheese which also supply fats, calcium, phosphorus and D-group vitamins.

Red and white meat, i.e., beef, pork, lamb, poultry, fish and eggs are protein-based foods rich in essential amino acids, fats, minerals (iron, phosphorus, magnesium and potassium), vitamins and fats.

Finally, the importance of consuming fruits and vegetables lies in the bioregulatory powers of these foods.

Examining the typical and unique features of the Mediterranean diet[36], it can be seen that it represents a typical example of a correct diet for adolescents.

Briefly, the guidelines to be followed in adopting eating habits and a lifestyle which promotes healthy growth in adolescents are:

- **adopt a healthy, balanced diet**, which, through alternating on a daily basis all primary foods, provides all the nutrients and micronutrients (calcium, iron, vitamins, etc.) required by adolescents;
- **avoid excessive calorie intake** by avoiding consumption of high-calorie foods or those rich in fats. Western countries find this message hard to perceive and adopt, also for psychological reasons. Parents, especially mothers, tend to blame themselves for not giving their child enough to eat, but never for giving them too much;
- **divide nutrients in a balanced way throughout the day** to assure proper equilibrium between animal and vegetable proteins which should be 1, between simple and complex sugars (through consumption of fewer sweets, more bread, potatoes, pasta or rice), and between animal and vegetable fats (using less lard and butter and more olive oil);

36 Willett WC, Mediterranean diet pyramid: a cultural model for healthy eating, American Journal of Clinical Nutrition, 1995.

Jodi Cobb/National Geographic Image Collection

- **reduce added salt to a minimum** in order to lower risk factors of developing high blood pressure, especially in adult years;
- **divide food consumption into 5 periods during the day**–breakfast, mid-morning snack, lunch, afternoon snack and supper;
- **avoid consuming food in moments other than the 5 mentioned above** as extra snacks, sweets and fast food products;
- **engage in physical activity** for at least one hour per day, both as sports activity and recreation;
- **reduce sedentary activity as much as possible**, especially that spent in front of the television or computer screen.

3. General Recommendations

A correct process of growth and development tied to a healthy diet provides the basis for maintaining good health following the growth years.

Luis Marden/National Geographic Image Collection

Bill Curtsinger/National Geographic Image Collection

Eating habits and lifestyles play a decisive role in preventing obesity and the four major non-communicable diseases. Prevention in this area is even more relevant for the younger generations.

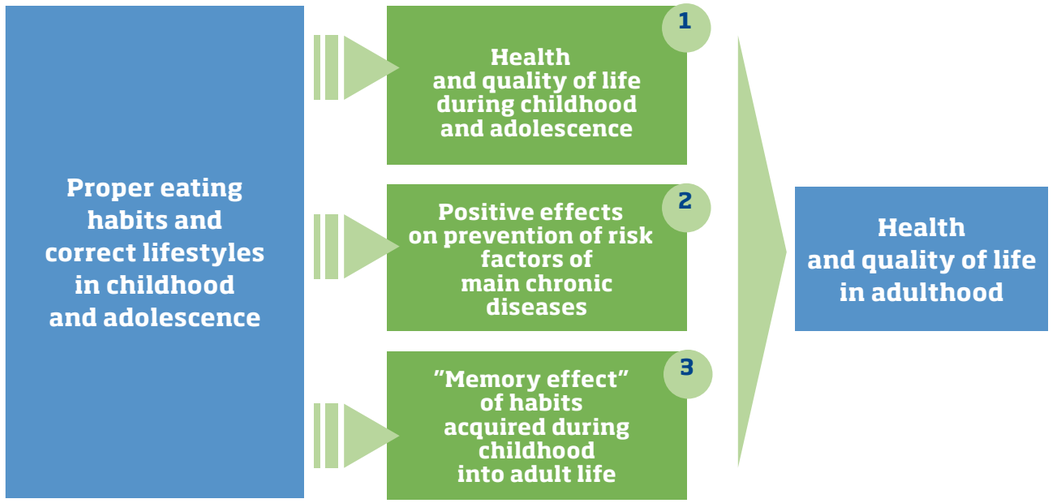
3.1 Some general points

In light of the evidence which has emerged during this study and analysis of it, it would seem opportune to stress, as a starting point, two basic aspects of a general nature.

First of all, **at all levels, there is growing awareness of the importance of adopting correct eating habits in the early years of an individual's life (up through adolescence) in order to maintain a good state of health including as an adult**.

Correct eating habits and behaviors adopted during the early years are decisive both in terms of health during childhood and adolescence themselves, as well as health and quality of life in subsequent years::

- a healthy diet and adoption of proper lifestyles allow the child and adolescent to **develop properly (both physically and mentally) and be healthy**;
- a correct process of growth and development tied to a healthy diet provides the basis for **maintaining good health following the growth years**;
- although difficult to verify scientifically, it is likely that here is a **"memory effect" benefit** which, through acquisition of **correct eating habits and lifestyles** during childhood and adolescence, makes it easier to maintain these in adulthood.



Secondly, **there has recently been a tremendous increase in awareness on a scientific and social level of the fundamental role of disease prevention, alongside their treatment**.

With respect to this, eating habits and lifestyles play a decisive role in preventing obesity and the four major non-communicable diseases (diabetes, metabolic syndrome, cardiovascular disease and cancer). Prevention in this area is even more relevant for the **younger generations**. In fact, the absence of a systematic and wide-spread promotion of correct eating habits and lifestyles for those in the very beginning of their lives would be unacceptable, both from the standpoint of the public health system, but also ethically and economically.

Prevention is one of the main lines of action for the future in guaranteeing the **sustainability of health care systems** affected by ever-growing levels of investment and operating costs, as is the case in virtually all countries of the Western world.

But despite the importance of this issue, it was only during the second half of the last century that there emerged the first observational studies aimed at underscoring the close relationship between individual and collective behavior and the onset of the major chronic diseases, and, as a result, that research began into the nature of the underlying social, environmental and cultural factors.

Nonetheless, **most of the studies conducted to-date have involved adults** and problems of a methodological, economic and organizational nature have made it difficult to extend research in a sufficiently detailed way to children and adolescents.

Despite this–and although the analytical picture within this document is still highly fragmentary–**the evidence supporting the overwhelming relevance of establishing correct eating habits from the very early years is undeniable**.

David Alan Harvey/National Geographic Image Collection

3.2 Proposals

Also in light of the two considerations above, we believe it even more necessary to:

1. Promote further scientific study

As mentioned elsewhere, growth-related nutritional issues remain a relatively little-studied area. Specifically:

- Study of the metabolic and endocrinologic effects resulting from consumption of foods and meals of varying types. The anatomical-functional consequences of different metabolic conditions which arise after meals are highly relevant in the development of degenerative chronic pathologies. Available data regarding this question in children is very limited;
- Study the short-, medium- and long-term effect of environmental pollution on metabolism and the immune and neuroendocrine system. Data indicating the impact of harmful substances in the environment and also transmitted through food on the metabolic equilibrium of children and young people is increasingly alarming;
- Study the relationship between specific nutritional factors, meal composition and diet, spread of nutrients over 24 hours, levels of motor activity, growth and the onset of main chronic diseases;
- Study the role of physical exercise in regulating quantitative-qualitative levels of food in children;
- Study the existing relationships between specific genetic structures (polymorphisms), nutritional habits, post-meal metabolic reactions and metabolic pathology in children.

2. Promote cooperation between the various players involved in child nutrition

Guaranteeing correct eating habits for children and adolescents would seem to involve necessarily a joint effort with the contribution of a number of players (school, family, pediatricians, sports groups, etc.) which take care of children in different moments of the day.

Often there is little coordination between their actions, and sometimes they even act according to contradictory approaches and goals.

For different reasons, **family** and **school** would appear to be the principal parties in efforts effective in teaching correct eating habits. While on the one hand **it is within the family that a child "learns" to eat** and internalizes eating behaviors that he or she would naturally be led to adopt, on the other, because of the growing importance of its presence in food-related questions and its potential to involve families themselves, **the school could, and must, play a truly active role in promoting balanced eating styles**, inviting families to understand which food choices are most appropriate and to "become allies" in a unified plan of action.

3. correctly structure initiatives according to the most effective international best practices

Despite the fact that scientific knowledge on this issue is still far from being optimal, the amount of concrete experience accumulated in formulating initiatives aimed at improving the approach to food in childhood is significant.

In particular, some principles seem to have become established and generally accepted, although not always adequately taken into consideration/implemented when drawing up initiatives involving nutrition and health in growth years:

- the initiatives drawn up must have a **medium-to-long-term time frame**. In fact, the lifestyle trends seen today must be profoundly modified–and in some cases reversed. This requires programs drawn up on the basis of a very ample time frame and adequate financial resources, in the knowledge that, over time, this investment will guarantee even substantial economic return. Initiatives that are too limited (in terms of time frame and funding) and oriented solely to the present, do not seem able to provide a lasting effect on family eating habits;
- issues tied to nutrition and lifestyle must be taken on using an **approach which links information and direct experience** ("active education"). The experimental route is unquestionably most effective when those involved are children. The road to healthy eating is part of an educational journey which helps to create awareness through educating tastes capable of appreciating foods which are traditionally "difficult" but excellent for health (for example, fruit and vegetables). Introducing these foods through a correct experience-based approach becomes decisive in defining the perceptions and beliefs which could even continue into adulthood;
- the recommendations provided must be **practical** and **implementable**. Too often, the instructions provided are correct but difficult to implement, or contradicted by day-to-day practices and habits, including institutionalized ones, which are very distant from those principles indicated as being optimal. An example of this last point is the availability in schools and children's hospitals of vending machines which contain only packaged snacks/candy/soft drinks, and no fruit, as would be hoped for given the recommendations provided by the medical bodies and institutions themselves which run these public places.

On the one hand it is within the family that a child "learns" to eat, on the other the school could, and must, play a truly active role in promoting balanced eating styles.

In general, it would be hoped that nutrition- and health-related initiatives during growth years would be (**at least**) **national in scope**, with the necessary **local focus**, which, although differentiated in terms of how they are implemented, would not differ at all in terms of substance from the guidelines and principles defined on a national (or supranational) level.

4. Promote the spread of correct nutritional information and promote prevention

The importance of the role of nutrition during growth phases must be further promoted with all health care workers and in families by fostering constant use of tools which actively control nutritional behavior (for example, through regular checking of the Body Mass Index).

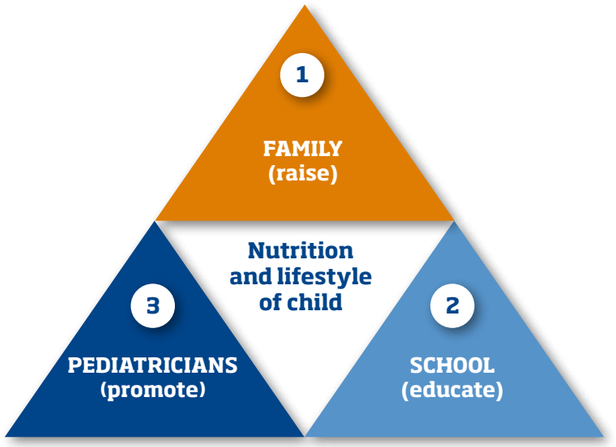
Pediatricians have a key role in this given their closer relationship with families as opposed to general practitioners who only begin care of adolescents when they are older.

3.3 Specific integrated initiatives

The *Barilla Center for Food & Nutrition*, in light of the considerations and proposals that have been made, believes that an integrated approach involving all the main public and private players represents a positive means for preparing the new generations to come.

The ***specific initiatives*** center around ***three macro areas of intervention***, one for each of the ***major players involved*** in the relationship between nutrition-health-well-being in childhood and adolescence:

School (primarily covering the years of compulsory education)



Based on the positive experience of programs implemented by several European governments, particularly the Italian government, and in line with the scientific recommendations and those of the European Union, and being aware that the schools, also in cooperation with the Ministries of Health, Agriculture, Youth Policies and others, are implementing or experimenting initiatives that should make it possible to achieve the goals described here, we are inviting all the leading public and private food information services to participate in the projects described, especially with regard to the Technical Scientific Committee "School and Food" of the Ministry for University and Research, for nutritional education in the schools."

In this view, we feel that coherent and synergetic implementation of the following actions can lead to a significant improvement in the lifestyle education of children within the school system.

- The introduction into the school lunch program of a range of foods selected by nutritionists to provide proper nutrition during the various phases of growth, and include all macro- and micronutrients.
  Foods should be selected paying special attention to the products of each individual territory, also in order to create a direct connection with the diets children are familiar with in daily family life;
- daily distribution of fruit to every student;
- organization and implementation of programs integrated with the courses in the school program of the main sports in which Italy's national teams are involved (swimming, track and field, football, basketball, volleyball, etc.) in order to initiate children in regular motor activity and sports that they can then continue on their own as they grow;
- definition and realization of concrete programs of active food education, centered on health and nutrition.

Pediatricians

We consider the pediatrician's role a fundamental one throughout the child's growth and development and are in favor of their greater involvement for a regular assessment of the conditions of every child's and adolescent's health, by means of a series of periodical measurements on the following:

- Growth (height, weight, etc.)
- Body Mass index
- Glycemia
- The main aspects of daily diet in the child's family
- Nutritional and lifestyle guidelines

In order to actually realize this initiative on a national basis, it seems necessary to identify proper forms of incentive to allow the role of the family pediatrician to become fully–even more so than currently–that of the first "gateway" to issues regarding proper eating habits and adequate physical activity for children and adolescents.

Family

The education of the family by the public sector institutions involved (Ministry of Health, Ministry of Public Instruction, Higher Education and Research, Ministry for Youth Policy, Ministry of Agricultural, Food and Forestry Policies, regional, provincial and municipal government) should be continued and maintained through public service campaigns to inform them of the importance of proper diet and lifestyle in childhood and adolescence.

Clearly, for the reasons illustrated above, the preferential channel will continue to be the school, with periodical meetings organized in respect of the programs and local governments.

3.4 Role of the agrifood industry

A longside the three main actors comprising the nucleus of the nutrition education/prevention "pyramid" for children, in recent years there has emerged (with ever-increasing awareness) the existence of a **role for the agrifood industry** that is as possible as it is necessary in making an active contribution to realizing proposals and offers coherent with recommendations regarding correct nutritional practices and lifestyles in children and adolescents, as well as actively promoting their adoption.

As already stressed in the recent paper by the Barilla Center for Food & Nutrition entitled "Alimentazione e Salute", there are three areas in particular in which the agrifood industry would be important:

- in **promoting healthy lifestyles and nutrition** from the very earliest years of life through defining and implementing manufacturing and communications strategies increasingly in line with recommendations which emerge from top-level scientific studies regarding the relationship between nutrition, lifestyle and health;
- in **improving available scientific knowledge** through promoting investment in applied research and the creation of joint university-industry groups which can work to fill the knowledge gap seen today in the field of the relationship between nutrition and health of children and adolescents;
- in **improving processes of communication** regarding the relationship between nutrition, lifestyle and health in childhood, providing in a simple, clear-cut way the nutritional values of food products and good nutritional practices through a range of available means of communication (web, advertising, packaging, etc.).

If the role of the agrifood industry is fundamental in terms of creating a positive relationship between nutrition and health, at all ages, its **importance is even more evident when attention is concentrated on growing children**.

While childhood is characterized by difficulty (on the part of the child) in truly comprehending phenomena around him/her and the role of diet which is totally mediated and interpreted by his/her parents, with adolescence there is a gradual loosening of the ties with family habits learned in the early years of life and the emergence of important phenomena in the life of the individual (both medical and social) which seem to have a profound influence on lifestyle and eating habits.

Within this context, the agrifood industry clearly emerges as one of the central players in an **information and prevention initiative** aimed at children and adolescents, that is truly **broad-ranging**, **integrated** and **efficacious**.

The agrifood industry has a primary role in providing adequate responses to the various lifestyles of individuals, both through product ranges that are properly profiled, as well as through coherent and responsible communication.

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