For Practitioner

Obesity and Overweight in Children - Epidemiology and Etiopathogeny

SIMONA COŞOVEANU, D. BULUCEA

Department of Pediatrics, University of Medicine and Pharmacy, Craiova;

ABSTRACT In the last few decades, obesity has become one of the most frequent nutritional diseases in the world, resembling a pandemy and being considered the 21st century disease. At present, one can notice an increased tendency with an epidemic character of obesity and overweight frequency, which came to affect, on a world scale, approximately 20-25% of children and 45-50% of the teenagers. According to a study carried out in 79 countries, WHO estimates that there are 250 million obese people in the world, among which approximately 22 million are children aged less than 5 years. Obesity is a plurifactorial disease, its occurrence supposing multiple interactions among genetic, neuroendocrine, social, behavioral, psychological or a combination of these, metabolic, cellular and molecular factors that lead to changes of the energetic balance.

KEY WORDS *epidemiology, etiopathogeny, overweight, obesity, child*

Introduction

In the last few decades, obesity has become one of the most frequent nutritional diseases in the world, resembling a pandemy and being considered the 21st century disease.

The prevention of obesity is a public health issue which imposes a careful monitoring of the children with a tendency in gaining weight. Obesity represents a major health problem which can lead to physical and psychological co-morbidities, such as diabetes mellitus type II, metabolic syndrome, cardiovascular diseases, and depressions (Summerbell, Waters, 2005; Hedley et al., 2004).

Obesity is the most frequent nutritional disorder of the child in the developed countries, representing one of the major public health problems in numerous regions of the world. First childhood obesity is frequent; the more precocious the onset moment and the more excessive weight of the child, the less favorable the obesity prognosis.

At present, one can notice an increased tendency with an epidemic character of obesity and overweight frequency, which came to affect, on a world scale, approximately 20-25% of children and 45-50% of the teenagers. A study carried out in 2009 (Cole et all.) showed that 25% of the obese adults were overweight children. Other studies show that overweight which occurs in children before the age of 8 years is associated to more severe obesity in adults [1]. The main moments in the history of obesity in children are displayed in table 1.

Epidemiologic Data

Data provided by **NHANES II** study (1976-1980) and **NHANES study 2003-2006** showed an increase of the overweight prevalence in all the age groups: in the kindergarten children aged 2-5 years from 5% to 12.4%; in the 6-11 year age group from 6.5 % to 17%, while in the 12-19 years age group from 5% to 17.6% [2]. A study published in 2003 by NHANES shows that, in 1996, in Canada, in the age group 7 to 13 years, the overweight prevalence was 33% for girls and 26% for boys, while the obesity prevalence was 10% for girls and 9% for boys. Data provided by **NHANES** study **(2003–2006)** showed, in children aged 12-19 years, higher obesity prevalence in boys (27.7%) than in girls (19.9%) [2].

In the **U.S.A.** 1 of 4 children aged between 6 and 17 years and 1 of 2 adults are overweight [1]. Thus, one can notice an increase in the obesity prevalence in the 6-14 year age group from 4% in the period between 1963 and 1965 to 13% in 1999; in the teenagers aged between 12 and 19 years from 5% in the period between 1966 and 1970 to 14% in 1999. The percentage of the overweight children doubled in the last two years, more than 30% being obese. In **Mexico,** one can notice an increase of 50% of obesity prevalence in children and adults in the last ten years. A study carried out between 2001 and 2002 shows an overweight prevalence of 34.5%, while the obesity registered 26.2%. The highest prevalence for obesity and overweight is cited in the **Pacific Isles** and **Saudi Arabia** [3]. In 2008, obesity prevalence was high in Indian children in America, Alaska natives (21.2%) and Hispanic ones (18.5%) and

was low in children in Asia (12.6%) and Pacific Islands (12.3%). The obesity prevalence in the developing countries for children aged 2-5 years increased from 12.4% in 1998 to 14.5% in 2003, and only to 14.6% in 2008 [4].

Table 1. Main moments in the history of obesity in children

Hippocrates	„Corpulence is not only a disease itself, but the harbinger of others".
1727	Short – first monograph on obesity, in English
1780	Cullen – classifies the diseases which include obesity
1849	Hassal – describes the structure and the development of the adipose cells
1866	Russell – describes sleep apnea as a complication of obesity
1869	Adolph Quetelet uses Body Mass Index (BMI)
1879	Hoglulele – describes the growing fat cells
1900	Babinski and Frohlich – describe the hypothalamic obesity syndrome
1912	Cushing – describes the Cushing-type obesity
1920	It is pointed out that obesity might be a genetic or hormonal problem
1940	The psychological theories on child obesity appear
1949	Fawcet – describes the brown adipose tissue (BAT)
1967	Stewart – uses the behavior therapy in the treatment of obesity
1968	Various – Association for the Study of Obesity (ASO), UK
1974	"The 1st International Congress on Obesity" (ICO), Royal College of Physicians, London.
1977	"The International Journal of Obesity" (IJO), the first journals appear
1977	"Growth Charts"- National Center for Health Statistics (NCHS), also adopted by WHO
1986	The European Association of Society Obesity (EASO) is founded
1988	Reaven – describes the metabolic X syndrome
1989	Strosberg at all. – identify the B3 adrenoreceptor, isolation of the human receptor CB1
1992	The Romanian Association for the Study of Obesity was founded (ARSO)
1994	The obesity gene which encodes the leptin synthesis, the ob gene (gene Lep), was discovered; it is located, in humans, on the long arm of the chromosome 7 (7q31)
1994	Friedman at all. – discovers leptin
1995	Isolation of the second receptor CB – 2 AG
1995	The International Obesity TaskForce (IOTF) was founded
1997	O'Rahilly at all. – describes mutations at the level of leptin and receptor 4 melanocortine as prime cause of human obesity
1999	Ghrelin, together with insulin, orexin, PYY 3-36, colecistokinine, adiponectin – coordinating role of the pro-inflammatory environment, admitted in obesity
2000	The 1977 NCHS growth maps revised by de CDC
2001	The Romanian Association for the Study of Obesity organizes the First National Congress "Obesity and the Associated Diseases", October 2001, Cluj-Napoca
2003	Snyder and colab. updated the "catalogue" of the human obesity genes. They drew up genomic regional maps for human obesity from 41 mendelian transmission syndromes.
2003	Every individual has genetically programmed both body mass/fat tissue mass and the physiological mechanism necessary to maintain them according to the encoding process (Ryder Sacher, Chadwich, Hogan)
2003	The CB1 receptors in the nucleus accumbens regulate the alimentary appetite through the diversity of sweet and fat food (Bensaid M.,Mol Pharm.,2003,63:908-14)
2003	Specialist Certificate of Obesity Professionals in Education (SCOPE)
2004	PPAR γ2 (role in adipose tissue differentiation) – the gene mutation predisposes to obesity (adipocytes leptin synthesis)
2005	Antagonists of RcCB => obesity therapeutic strategy (Cota D., Woods SC., Curr. Opin. Endocrinol Diabetes, 2005)
2005	The members of the American Cardiology Academy drew up new recommendations (September 2005) regarding nutrition practice of physical exercises since birth, recommendations also adopted by the American Pediatric Academy (Gidding şi colab. Circulation 2005; 112: 2061-2075)
2006	Recent research studies carried out by Nikhil Dhurandhar and Biomedical Research Centre Pennington within the Louisiana University System – viral etiology of obesity – adenovirus 36 (Human adenovirus 36, HAdV-36, AD-36) demonstrated a positive correlation between the fat mass in the body and the AD-36 antibodies in the blood
2006	"The International Journal of Pediatric Obesity" (IJPO) appears
2008	Romania, Law 123/2008 on healthy food in the pre-university educational institutions
2009	FTO gene – discovered following a study on a sample of 39,000 individuals belonging to the Caucasian race; the gene was met among population, 63% of the people on study having one or two copies of it; 47% had only one type of the FTO gene and 16% two types.
May, 22	European Obesity Day

Epidemiologic Data

Data provided by **NHANES II** study (1976-1980) and **NHANES study 2003-2006** showed an increase of the overweight prevalence in all the age groups: in the kindergarten children aged 2-5 years from 5% to 12.4%; in the 6-11 year age group from 6.5 % to 17%, while in the 12-19 years age group from 5% to 17.6% [2]. A study published in 2003 by NHANES shows that, in 1996, in Canada, in the age group 7 to 13 years, the overweight prevalence was 33% for girls and 26% for boys, while the obesity prevalence was 10% for girls and 9% for boys. Data provided by **NHANES** study **(2003–2006)** showed, in children aged 12-19 years, higher obesity prevalence in boys (27.7%) than in girls (19.9%) [2].

In the **U.S.A.** 1 of 4 children aged between 6 and 17 years and 1 of 2 adults are overweight [1]. Thus, one can notice an increase in the obesity prevalence in the 6-14 year age group from 4% in the period between 1963 and 1965 to 13% in

1999; in the teenagers aged between 12 and 19 years from 5% in the period between 1966 and 1970 to 14% in 1999. The percentage of the overweight children doubled in the last two years, more than 30% being obese. In **Mexico,** one can notice an increase of 50% of obesity prevalence in children and adults in the last ten years. A study carried out between 2001 and 2002 shows an overweight prevalence of 34.5%, while the obesity registered 26.2%. The highest prevalence for obesity and overweight is cited in the **Pacific Isles** and **Saudi Arabia** [3]. In 2008, obesity prevalence was high in Indian children in America, Alaska natives (21.2%) and Hispanic ones (18.5%) and was low in children in Asia (12.6%) and Pacific Islands (12.3%). The obesity prevalence in the developing countries for children aged 2-5 years increased from 12.4% in 1998 to 14.5% in 2003, and only to 14.6% in 2008 [4].

Situation of Obesity in Children in Europe

According to a study carried out in 79 countries, WHO estimates that there are 250 million obese people in the world, among which approximately 22 million are children aged less than 5 years. The study stresses upon the fact that 50% of the obese children will become obese adults; WHO estimates about 300 million obese for 2025 [4,5].

In most of the Western Europe countries, obesity has a frequency of 10-25%; in the Eastern European and Mediterranean countries the frequency is much higher, reaching a 40% in women [4]. The **IOTF** report showed that 1 in 10 children is overweight, leading to a total of 155 million, among which 30 to 45 million are regarded as obese. The report shows that the obesity prevalence in children is getting higher in the Southern Europe countries [3,4].

England – in 1999 the overweight prevalence increased from 22%, when 6 years of age, to 31% when 15 years, while obesity increased from 10% to 17% [2,6]. **Germany** – a study carried out over a 20 year-period shows similar dynamics; overweight increased from 10% to 16.3%, between 1975 and 1995, more frequent in girls; for the same period, obesity increased from 5.3% to 8.2% [2,7]. In **France,** a study carried out in 2000/2001 on a group of children showed an obesity prevalence of about 3.8%, and an overweight prevalence of 14% [6]. In **Greece,** the overweight prevalence in boys is of 18.1%, while in girls is of 16.8%; obesity prevalence is 11.2% in boys and 11.4% in girls for the 2-6 years age group, according to a study carried out in 2004 and reported by NHANES. Recent studies show that 36% of the 9 year old children in **Italy and Sicily** are overweight or obese. In **Spain,** 27% of the children and teenagers are obese; a study carried out between 1998 and 2000 shows an increased overweight prevalence of 31.4% in boys, and of 32.4% in girls, while for obesity of 10.4% in boys and 10.2% in girls [3]. The lowest obesity prevalence is registered in **Bulgaria** 2.2% in girls, followed by **Switzerland** 2.4%, **Netherland** 2.6% and **Norway** 3%, according to a study reported by NHANES in 2002 [6].

Situation of Obesity in Children in Romania

In **Romania,** according to a study carried out in the western part of the country, there were identified, among children aged between 3 months and 16 years, 14.7% obese children, the obesity frequency being slowly increased in school girls. Another study which was performed in 2000, on a group of 5250 children, aged 0-16 years, shows 18% obese infants, 15% 1-3 years obese children and 14% school children [8].

NCHS/WHO Source: National Nutritional Surveillance Programme, 1993-2002, Bucharest, "Alfred Rusescu" Institute for Mother and Child Care, 2003 shows a prevalence of overweight in children aged 0 to 4 years, 6.4 in girls and 5.5% in boys [2]. A study carried out between 2005 and 2006 in children aged 11 to 15 years (published in a report of The International Association for the Study of Obesity (IASO), London, April, 2009), showed that, in Romania, the overweight prevalence is 14.7% in girls and 8.7% in boys, the highest prevalence being registered in Malta (31% in boys and 28% in girls) and the lowest in Lithuania (10.3% in boys and 4.7% in girls).

Obesity Etiopathogeny

Obesity is a plurifactorial disease, its occurrence supposing multiple interactions among genetic, neuroendocrine, social, behavioral, psychological or a combination of these (alteration of some enzyme activity), metabolic, cellular and molecular factors that lead to changes of the energetic balance [8].

Although the obesity etiology is multi-factorial, it is mainly connected to a certain caloric intake which represents more than the energetic needs of the body (hyperphagia). The excessive caloric intake of the diet leads to an excess of energy deposits under the form of triglycerides in the adipose tissue, thus increasing the volume and/or the number of adipocytes. The weight excess occurs only when the intake energy is

higher, for a sufficient period of time, than the energetic consumption. Individual and environmental factors interfere, using neuroendocrine and metabolic ways.

The complex interactions which determine the occurrence of the polygenic obesity prove that the genetic, social, behavioral and environmental factors can influence the obesity phenotype (Table 2).

Table 2. Etiopathogenic factors in obesity, according to BASDEVANT (1996)

	Predisposing factors	Triggering factors	Amplifying/ maintaining factors
Genetic or constitutional factors	Family history	Changes in the hormonal status	Adipose tissue hyperplasia
	Body weight to the upper limit of normal		Hyperinsulinism
	Metabolic efficiency		
	Neuro-endocrine hyper-activity to stress		Insulin-resistance
	Overweight in childhood		
Environmental factors	Sedentary lifestyle	Stress	
	Meal frequency and composition	Lifestyle or diet	
	Socio-economic level	Alimentary behavior dysfunctions	
	Lifestyle	Depressions	
		Drugs	

The risk of the children who were obese in their first years of life to become obese adults is 80% for those with obese parents and 40% for those with only one obese parent. The newly-born with obese mothers are more frequently macrosomes and in the long run they can develop obesity [8].

There are genes with a role in differentiating the adipose tissue, whose mutation would lead to obesity through the acceleration of the adipocyte differentiation pace and the increase of fat accumulation: **PPAR γ2** (role in differentiating the adipose tissue) – the mutation at the level of an ob gene, located on the long arm of the chromosome 7, predisposes to obesity; the **FTO gene** was discovered through the study of a group of 39,000 individuals, belonging to the Caucasian race.

In 1994, the obesity gene which encodes **leptin** was discovered in mice. The adipocytes synthesize a hormone-role protein, the leptin encoded by the mRNA transcribed by the **ob gene**. Leptin is regulated by numerous environment factors and hormonal influences; it is a regulator of the food intake and of the lipidic and glucidic metabolism; it stimulates the reproduction system, the initiation of puberty, the regulation of the growth process (by stimulating the secretion of the somatotrop hormone), and of the immune system. The leptin serum level varies according to age and sex and it correlates with the adipose tissue body.

The individual factors are represented by:

Genetic factors

Age: obesity can occur at any time, there are some "obesogen" periods related to the development and the changing of the adipose tissue: pre-birth period, early childhood, puberty, adolescence in females.

Nervous factors: CNS lesions, AD 36 adenovirus

Psychological factors: an important role in the impulsive increase of the food intake through dysfunctions of alimentary behavior

Behavioral factors: increase of the food intake (alimentary inquiry), sedentary behavior, low energetic consumption (physical activity inquiry)

Drug-related: corticosteroids, antihistaminic, phenotiasine, tricyclic antidepressants

Metabolic factors

Endocrine factors

The environmental factors are represented by: food availability (defective feeding habits rich in calories, some family feeding habits) and social, cultural and familial influences. Excessive food intake obviously represents the main exogenous factor with a role in the obesity genesis and perpetuation. For older ages, studies showed that children food preferences resemble much to their parents'. The present food environments are obesogen, being rich in sugars and fats; changes of the children's diet: both qualitative and quantitative, with solid aliments, fast-food big portions. The season influences the energetic consumption, the greatest consumption being in spring. Children spend, in front of the TV screen and computer, more time than doing physical activities. 83% of the children watch TV more than 5 hours a day, 34% spend more than 4 hours a day in front of the computer, 25% are completely sedentary and only 26% take part in school physical activities [9].

Conclusions

Acquiring healthy eating habits since an early age is very important for staying healthy for a longer time and preventing obesity. Obesity

prevention represents a public health issue which demands a careful monitoring of the children with a tendency to gain in weight. Most researchers stress upon the idea that obesity which occurs in childhood and maintained when adult is more difficult to treat than the obesity occurred when an adult. Children obesity in the 21st century inevitably leads to a decrease of life expectancy.

References

1. Ogden CL, Flegal KM, Carroll MD, Johnson CL. Overweight and obesity among US children, adolescents, and adults, 1999-2002. JAMA 291:2847-50, 2004.
2. www.cdc.gov/nchs/NHANES 2005-2006. Prevalence of Overweight Among Children and Adolescents: United States; Childhood Overweight.
3. James, Philip. IOTF Childhood Obesity Report, May 2004.
4. www.who.int/child-adolescent-health. Obesity: preventing and managing the global epidemic, Report of a WHO Consultation, Geneva, 2004.
5. Barlow Sarah E., Expert Committee Recommendations Regarding the Prevention, Assessment, and Treatment of Child and Adolescent Overweight and Obesity: Summary Report, PEDIATRICS Vol. 120 Supplement December 2007, pp. S164-S192.
6. Lissau I. Overweight and obesity epidemic among children. Answer from European countries. International Journal of Relat Metab Disord 2004, 28 (Suppl 3):S10-15.
7. Ogden C.L., Kuczmarski K.J., Flegal K.M., Centers for Disease Control and Prevention 2000, Growth Charts for the Unites States, Pediatrics 109, 2002,45-60.
8. Popa Ioan, Brega Daniela, Alexa Aurora. Obezitatea copilului şi ţesutul adipos, Editura Mirton, Timişoara, 2001, pag. 1-325.
9. Leigh Deborah Anderson, Bernadette Mazurek Melnyk, Prevention and Early Treatment of Overweight and Obesity in Young Children: A Critical Review and Appraisal of the Evidence, Pediatr Nurs., 2007; 33(2):149-161.

Correspondence Adress: Simona Coşoveanu, MD, OhD, Department of Pediatrics, University of Medicine and Pharmacy of Craiova, Str Petru Rares nr. 4, 200456, Craiova, Dolj, România; E-mail: scosoveanu@yahoo.com