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CARDIOVASCULAR RISK FACTORS IN CHILDHOOD OBESITY

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REZUMAT

FACTORII DE RISC CARDIOVASCULAR LA COPIII CU OBEZITATE

Cuvinte-cheie: obezitate, factori de risc cardiovascular, copii

Obezitatea în copilărie este considerată o condiţie ce se manifestă prin acumularea în exces de ţesut adipos subcutanat, cu afectare negativă asupra sănătăţii. Prevalenţa şi datele epidemiologice ale obezităţii din 1975 până 2018, timp de 43 de ani, studiată la copii cu vârsta cuprinsă între 5 şi 19 ani, s-a triplat, de la 4% în 1975 la 18%. În 2016, 18% fetiţe şi 19% băieţi erau supraponderali. În clasificarea masei corporale, Indicele Masei Corporale este considerat cel mai util indicator de risc în sănătate printre populaţia supraponderală şi subponderală. Factorii de risc pentru obezitate nonmodificabili, cum sunt etnia, sexul şi starea familială sunt discutabili la copii. Alţi factori de risc pentru obezitate includ modul de viaţă şi deprinderile în familie ce se referă la copii, aşa ca nutriţia, durata şi calitatea somnului. Semnele preclinice ale maladiilor cardiovasculare pot fi identificate la copiii şi adolescenţii obezi prin prezenţa marcherilor precoce de aterosclerază.

РЕЗЮМЕ

ФАКТОРЫ РИСКА ДЛЯ СЕРДЕЧНО-СОСУДИСТЫХ ЗАБОЛЕВАНИЙ У ДЕТЕЙ С ОЖИРЕНИЕМ

Ключевые слова: ожирение, сердечно-сосудистые факторы риска, дети.

Ожирение в детском возрасте считается состоянием, которое проявляется накоплением избытка подкожной жировой ткани, что негативно сказывается на здоровье ребенка. Распространенность и эпидемиологические данные распространенности ожирения изученные за 43 годаб начиная с 1975 по 2018 года, у детей в возрасте от 5 до 19 лет, указывает на то что частота данного состояния утроились: с 4% в 1975 году по сравнению с 18% в 2016 году, в котором 18% девочек и 19 % мальчиков имели избыточный вес. В классификации вариабельности массы тела, Индекс Массы Тела считается наиболее полезным показателем для оценки риска для здоровья среди населения с избыточным или недостаточным весом. Факторы риска ожирения не поддающиеся влиянию, такие как этническая принадлежность, пол и семейное положение, до сих пор обсуждаются у детей. Другие факторы риска ожирения включают образ жизни и семейные навыки у детей, такие как питание, продолжительность и качество сна. Преклинические признаки сердечно-сосудистых заболеваний могут быть выявлены у детей и подростков с ожирением при наличии ранних маркеров атеросклероза.

Introduction

Obesity of childhood and infancy consider as a condition that manifested by excess body fat accumulation, which eventually negatively affects a child's health. BMI is easy calculation that include weight and height (weight in kg/height in meters ^2). Waist circumference is highly correlated with visceral adipose tissue. According to both the WHO and CDC (Center for Disease Control and Prevention) obesity and overweight define as: WHO parameters for BMI-for-age parameters are defined by standard deviations and describe overweight to be greater than +1standard deviation from the mean (equivalent to BMI=25 kg/m2 at 19 years) and obese as +2 standard deviations from the mean for 5 to 19 year-olds (equivalent to BMI=30 kg/m2 at 19 years).

The „Center for Disease Control and Prevention” defined overweight as at or above the 95th percentile of body mass index (BMI) for age and „at risk for overweight” as between 85th to 95th percentile of BMI for age [1, 2, 9].

Epidemiological data about obesity

Prevalence and epidemical data since 1975 till 2018 (43 years) obesity, in children between ages of 5-19, has been more than tripled itself Worldwide, 4% in 1975, compare to over 18% in 2016 (18% of girls and 19% of boys were

overweight). When in 2016 1.9 billion adults (39%) were overweight and from these over 650 million were obese (13%). In 2016 , 41 million children under the age of 5 considered as obese or overweight, and between ages 5-19 more them 340 million children.

According to the „National Child Measurement Programme" research that collected data between the years 2012-2013 from 582 899 children, aged 4–5 years and 485 362 children aged 10–11 years. (All the children was English National child).

The disease Control and Prevention obesity and overweight has recently raised the notion that should the alarming increase in childhood obesity not be reversed, the consequences may make the current pediatric population be the first generation to not exceed the life span of their parents. Studies have indicated that childhood obesity must be attacked prior to the teen years. Twenty percent of obese 4-year-old children will grow up to become obese adults; 80% of obese teens will continue their obesity into adulthood [11].

Classification of obesity:

In the classification of body weight, BMI, an index of weight to height (kg/m2), is generally recognized as the most useful indicator of health risk among people who are over-or underweight. For the CDC, a BMI greater than the 85th percentile but less than the 95th percentile is considered overweight, and a BMI of greater than or equal to the 95th percentile is considered obese [1, 2].

Table 1. Classification of overweight and obesity by body mass index [6]

Classification of overweight and obesity by body mass index		
	Obesity class	**BMI**
Underweight		<18.5
Normal/Acceptable		18.5 – 24.9
Overweight		25 – 29.9
Medically obese	I	30 – 34.9
	II	35 – 39.9
Extreme obesity	III	>40

Obesity classify according to weight and height whereas the value is less than 18.5 it consider as underweight, values between 18.6-24.9 consider as balance between weight and height. From 25.1 and above value is indicate overweight, obesity and extreme obesity respectively.

Clearer guidelines now exist to define severe obesity as 120% of the 95th percentile for body-mass index and to define markedly severe obesity as 140% of the 95th percentile. As children approach adulthood, these high percentile curves approximate a BMI of at least 35 for severe obesity (class II obesity) and a BMI of at least 40 for markedly severe obesity (class III obesity) [15].

Risk factors of childhood obesity

Some of risk factor for obesity we already discussed like ethnicity, gender, family status, those are non-modifiable risk factors. Other risk factor include lifestyle behavior of the family of the children. Those risk factors including nutrition, and duration and quality of sleep. Sleep also influence by TV in bedroom, because it prolong the time needed for sleep, and decrease the nighttime sleep duration.

Also familial risk factor can also contribute to obesity, like parent BMI, family history of overweight or obesity and maternal education, and TV in view where family eats most of meals. If speaking about nutrition of children it first factor that influence the most the weight of children is sugar beverages including juice, candy sweets, fast foods, snacks (both sweet and salty). As well low amount of healthy food like milk products fresh fruits vegetables/day. Low physical activity and prolong time spent at home watch TV/day are also risk factor for obesity in children.

Obesity is associated with numerous comorbidities such as CVD, type 2 diabetes, hypertension, certain cancers, and sleep apnea. In fact, obesity is an independent risk factor for CVD, and CVD risks have been documented in obese children. Obesity may affect the heart through its influence on known risk factors such as dyslipidemia, hypertension, glucose intolerance, inflammatory markers, obstructive sleep apnea/ hypoventilation, CHD, heart failure, and sudden death through its impact on the cardiovascular system [11].

Hemodynamic changes that associated with obesity

Obesity produces an increment in total blood volume and cardiac output that is caused in part by the increased metabolic demand induced by excess body weight. Thus, at any given level of activity, the cardiac workload is greater for obese subjects. Obese subjects have higher cardiac output and a lower total peripheral resistance than do lean individuals. Also, in obesity, the Frank-Starling curve is shifted to the left because of increases in left ventricular filling pressure and volume, which over time may produce chamber dilation. Ventricular chamber dilation may then lead to increased wall stress, which predisposes to an increase in myocardial mass and ultimately to left ventricular hypertrophy, characteristically of the eccentric type [10]

Effects on Ventricular Function

In humans and most animal models, the development of obesity leads not only to increased fat depots in classic adipose tissue locations but also to significant lipid deposits in other organs. With fat gain, lipid deposition can impair tissue and organ function in 2 possible ways:

(1) The size of fat pads around key organs may increase substantially, modifying organ function either by simple physical compression or because peri-organe fat cells may secrete various locally acting molecules, Strain and strain rate, assessed by tissue Doppler, are related to heart fiber shortening and the speed of fiber shortening, respectively [7, 12].

(2) Lipid accumulation can occur in non-adipose cells and may lead to cell dysfunction or cell death, a phenomenon known as lipotoxicity, which manifested as systolic and diastolic dysfunction [7, 12].

Cardiomyopathy of Obesity (Adipositas Cordis)

Initially, the fatty heart probably is not an infiltrative process but is a metaplastic phenomenon. Metaplasia is a reversible change in which one adult cell type (epithelial or mesenchymal) is replaced by another adult cell type. Cords of cells can gradually accumulate fat between muscle fibers or cause myocyte degeneration, resulting in cardiac conduction defects. When the right ventricle is involved, the sinus node musculature, the atrioventricular node, the right bundle branch, might be replaced by fat. Occasionally, a pattern of restrictive cardiomyopathy develops. In this situation, small irregular aggregates and bands of adipose tissue separate myocardial cells, a potential result of pressure-induced atrophy from the intervening fat [5, 8].

Cardiovascular manifestation of obese children

In children there are some early atherosclerosis markers which indicate preclinical CVD and can be found in obese children and adolescents. Fatty streaks & fibrous plaques in the aorta, although reversible, arise at around 3 years of age. Their formation is connected with high concentration of LDL-cholesterol and proinflammatory state.The next early marker of atherosclerosis, related to CVD risk in adults is increased arterial and venous stiffness [16].

Vascular stiffness is not only increased in the central arteries but also in pulmonary artery, what can be an early marker of pulmonary hypertension [3, 4].

In obese children and adolescents some impairment of cardiac structure and function can be found. Left atrial and left ventricle (LV) dimension as well as LV mass are significantly greater in children with obesity compared to children with normal BMI. Also geometric changes consistent with cardiac remodeling are present in obese youth. LV hypertrophy is potentiated by obesity and has been demonstrated to predict an increased incidence of clinical events, including death caused by CVD.

Another important marker for obesity is increased epicardial fat deposition. In obese children epicardial fat is related to BMI, carotid IMT, left atrium volume, LV mass.

Flow mediated-dilatation (FMD) assessed by noninvasive ultrasound examination is an early clinical indicator of atherosclerosis and endothelium damage**.** Several studies have reported that children with obesity have lower FMD compared to children with healthy weight [14].

Paraclinical cardiovascular manifestation in obese children:

The alterations seen are nonspecific flattening of the T wave in the inferolateral leads and voltage criteria for left atrial abnormality. More frequent ST-segment depression is seen in overweight patients with CHD. Weight loss induces a rightward shift of the QRS axis. Other common changes in Electrocardiogram of obese children may include: ↑ Heart rate, ↑PR interval, QT dispersion, ST-T abnormalities.

Doppler evaluation may be used to present fat accumulation in cardiac tissue, but if not technically accessible, transmitral Doppler image may properly evaluate the presence of left ventricular diastolic dysfunction [13].

Transesophageal echocardiography may be of diagnostic use in the evaluation of the presence of CHD in severely obese individuals.

Coronary artery disease my assessed by using nuclear cardiology imaging.

In method a dipyridamole thallium 201 or technetium 99m perfusion scan may be used for evaluating the presence of ischemic heart disease.

Endothelia dysfunction

BMI was highly associated with systemic oxidative stress, as determined by creatinine-indexed urinary 8-epi-PGF2α levels. Also decrease in the function of NO would result in vasoconstriction and an increase in vascular resistance that may predispose to CVD risk factors such as hypertension.

Pulmonary Hypertension

Pulmonary hypertension may be associated with morbid obesity, particularly during exercise, and may be associated with hemodynamic evidence of pulmonary arteriolar hypertrophy. Obesity is also associated with sleep apnea and alveolar hypoventilation, alveolar hypoxia being the most potent stimulus for pulmonary vasoconstriction [7].

Obesity in children is associated with risk of hypertension and cardiac dysfunction.

Table 2. Researches in cardiovascular manifestation in obese

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Name of study, year	Material and method	Results
Evaluation of LV function in obese children without hypertention by a tissue Doppler imaging study, 2018	25 children with BMI > 30 and control of 25 healthy children with BMI <25 (ECG, ECHO, included standard and pulse wave Doppler and tissue Doppler imaging)	Obesity in children without hypertention is associated with subclinical systolic and diastolic cardiac dysfunction
Change in Weight Status and Development of Hypertension, 2016	Retrospective study of 101 606 subjects age 3 to 17 years from USA (Height, weight, BMI and BP age, gender,)	During 3.1 years of follow-up, 0.3% of subjects developed AHT. Obese children ages 3-11 had two fold increased risk of developing AHT compared with healthy weight children.
Increased ambulatory arterial stiffness index in obese children, 2015	Cross section measurment of ambulatory arterial stiffness index in 101 obese children ages 9-14 (ABPM, BMI)	AASI was significantly higher in obese children compared to controls
The effect of childhood obesity on cardiac function, 2014	30 obese children and 30 control in ages of 8-17. (BMI, ECG ECHO, treadmill test)	ECG – P waive dispersion in obese ECHO – end systolic diameter, LV posterior wall thickness interventricular septum there significantly greater in obese children. Treadmill test- exercise capacity was found to be lower and the hemodynamic respond to exercise is defect in obese children.
Association between obesity and ECG variables in children and adolescents: A cross-sectional study, 2013	Cross-sectional observational study of 5,556 students aged 5–18 years was performed (BMI, WC, blood pressure and standard 12-lead ECGs)	Increase HR, longer PR intervals, wider QRS, frontal P-wave compared with normal weight groups within normotensive or hypertensive subjects.

Conclusions

1. Worldwide prevalence of childhood obesity is 18% in 2016 (18% of girls and 19% of boys were overweight), 41 million children under the age of 5 considered as obese or overweight, and between ages 5-19 more them 340 million children, and most of cases are Caucasians.
2. Diagnosis of obesity is based on BMI and growth charts, glucose and lipid profile, thyroid function and karyotyping and diagnosis of other comorbidities.
3. The major pathogenetic factors of cardiovascular damage in obese children are: endothelial dysfunction, sympathetic nervous system over-activation, accumulation of fat in myocardium, all lead to atrial and ventricle stiffness and development of cardiac dysfunction.
4. Management of obesity in children include lifestyle modification and increase physical activity.

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