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Epidemiological and Clinical Aspects in a Developing Country

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1. Introduction

There is growing prevalence of cardiovascular diseases (CVD) and diabetes mellitus type 2 (DM2) in the child and youth population, and particularly in young adults, secondary to an increase in their risk factors, which present themselves at very early stages of life. Among these, the most prevalent is obesity, which may increase rates of dyslipidemia, arterial hypertension (AH) and carbohydrate metabolism disorders, which are also recognized risk factors for cardiometabolic diseases (CMD).

High prevalence of obesity has also been found in the pediatric population worldwide. An epidemiological study conducted in Feira de Santana, a city in the northeast of Brazil, including children from 5 to 9 years old showed rates of 9.1% and 4.4% for overweight and obesity respectively, confirming the finding of obesity at early stages of life.

The literature has pointed out to the relationship between obesity in youth and premature death due to endogenous causes of cardiac/metabolic origin. It is therefore fundamental to know how and when the risk factors for CMD begin to affect vascular function and structure, and particularly, how to detect them early in order to enable the development of truly primary preventive strategies. This would make it possible to change the epidemiology of these chronic diseases, with consequent reduction in psychosocial and economic cost to the population and Health System, which is especially important in factor in developing countries.

2. Impact of obesity on cardiometabolic risk factors in youth

Obesity (defined as body mass Index [BMI] > 95th percentile, or BMI score z > 2.0) is a well defined and very complex disease of which overweight is merely one of the signs. Increasing obesity prevalence in youth over the last three decades has led to growing evidence of its implications for human health. Based on longitudinal studies, overweight has been shown to be an important risk factor for the development of atherosclerotic CVD, carbohydrate metabolism disorders, obstructive sleep apnea, cancers, intellectual deterioration, among others, therefore presenting elevated cumulative morbid-mortality.

A follow-up study of American indigenous children over a mean period of 23.9 years, demonstrated that factors such as obesity, particularly the abdominal type (defined as waist circumference [WC] > 75th percentile), diminished glucose tolerance, and childhood AH are involved in the development of premature death and DM. In addition to obesity being the

earliest event in this chain of morbidity, the deregulation of glycemic homeostasis is probably the most important mediator between overweight and death.

Nevertheless, a significant proportion of obese individuals may attain longevity without the previously mentioned comorbidities. This is due to the fact that the determinant of individual metabolic risk associated with accumulation of adipose tissue (AT) is not represented by its excess only, but above all, by its distribution, which can be determined by means of simple and available techniques such as WC measurement, as previously mentioned.

AT is recognized as the largest energy store of free fatty acids (FFA) and triglycerides (TG), and more recently as an endocrine organ that regulates the secretion of adipokines, which coordinate energy metabolism, insulin sensitivity and feeding behavior, not only in adults but also in pediatric populations. Imbalance between visceral and subcutaneous AT is capable of altering its physiology. In obese individuals, especially those with abdominal obesity, there is an increase of cytokines, such as interleukins (IL), tumor necrosis factor-alpha (TNF-α), c-reactive protein (CRP), plasminogen activator inhibitor (PAI-1) and fibrinogen among others, known for their proinflammatory, prothrombotic and proatherogenic actions, and a decrease in a cytokine with opposite characteristics, called adiponectin. In addition, the adipocytes that constitute visceral AT present intense lipolytic activity and when in excess, promote an increase of FFA circulanting levels that contribute to the presence of ectopic fat deposition.

These two basic mechanisms (imbalance in cytokine production and increase in FFA) favor both fat deposition in non habitual sites essential to the maintenance of glucose homeostasis, such as pancreas, liver and muscle, among others. This may lead to the development of insulin resistance (IR) and states of chronic inflammation with significant impact on carbohydrate metabolism and vascular system, promoting endothelial dysfunction. The inflammatory state is recognized by the increase in some cytokines (CRP, IL-6, TNF-α, etc) and is a great predictor of CVD. Therefore, it is rational to include CRP, especially high-sensitivity CRP (hs-CRP), in screening for the risk of CVD, also in the pediatric population at risk of these diseases.

Fatty liver deposition or hepatic steatosis (HS) is considered a hepatic component of the metabolic syndrome (MS) by the International Diabetes Federation (IDF), and in adult population it is an established predictor of dysglycemia and DM2. In youth, an association between obesity, particularly abdominal obesity and HS has been confirmed. Furthermore, the degree of steatosis in the liver has a decisive influence on the development of alterations in glycidic metabolism, with an important increase in hepatic glucose production, due to increase in gluconeogenesis.

It is thus imperative to conduct studies on ectopic fat deposits in youths with excessive weight in order to diagnose individuals with this alteration and calculate a risk score for CVD and DM. This screening may be done by means of simple techniques such as hepatic enzyme measurements (aspartate aminotransferase [AST], alanine aminotransferase [ALT] and hepatic ultrasound and/or sophisticated techniques (not always available in developing countries) such as nuclear magnetic resonance (NMR) with spectroscopy or hepatic biopsy, which is an invasive method, especially for children. Research in intramyocellular fat using NMR is also fundamental for determining peripheral muscle insulin sensitivity however the technique is not available for clinical use.

2.1 Cardiovascular system

Cardiovascular screening is normally recommended for adults, especially those with a family history positive for CVD. Nevertheless the combination of atherogenic diet, sedentary lifestyle and genetic have resulted in overweight and atherogenic dyslipidemia (decrease in high-density-lipoprotein cholesterol [HDL-C], increase in low-density-lipoprotein cholesterol [LDL-C] and TG at very early stages of life, thus anticipating the need for screening the cardiovascular system.

Although the vascular pathology in children with obesity and DM has been described, the course of development of these abnormalities has not yet been fully explained. In adults, abnormalities in vascular function precede the development of the anatomic or structural pathology. Vascular dysfunction, including reduction in endothelial function and vascular complacency and increase in inflammatory markers are therefore the initial findings in subjects with obesity, dyslipidemia, AH and carbohydrate metabolism disorders. Inflammation and maintenance of these risk factors subsequently lead to the development of atherosclerosis with alteration in vascular structure and increase in its rigidity.

2.2 Mechanism of atherogenesis

When elevated, LDL-C infiltrates the arterial endothelium, producing fat striae, even at very early ages in life (1st and 2nd decades) and if dyslipidemia persists, various subtypes of white globules, similar in shape, infiltrate the vascular wall and secrete inflammatory cytokines and oxidative molecules, with development of an inflammatory state and oxidative stress (OS).

OS, defined as imbalance between the concentrations of reactive oxygen species (ROS), such as superoxide and antioxidants (superoxide dismutase and catalase, among others), are essential for the development of endothelial damage, representing the initial and fundamental stage that is interposed between the formation of atherosclerotic plaque and the thrombus. Signaling pathways that regulate cytokine expression, such as the nuclear factor kappa B transcriptional pathway (NF-kB), is also activated by OS, resulting in the induction of adhesion molecule expression and inflammation on the vascular wall, contributing to the atherogenic process. In association, the clotting cascade and platelet aggregation are activated in an effort to repair the atheromatous lesion. This process can induce occlusive thrombi, infarctions and generalized micro and macro-vascular disease. Some systemic markers that represent OS have been identified in youngsters, confirming early onset of the atherosclerotic process.

In various studies, including our study in adolescents, inflammation markers, such as the simple overall leukocyte count and high-sensitivity CRP (hs-CRP) have been shown to be elevated in this group with clear demonstration of the relationship between inflammation and obesity, MS and a number of its components. The clinical usefulness of monitoring these markers in the pediatric population has not been well studied, nevertheless, some authors recommend that it should be measured, based on the hypothesis that the subclinical inflammation present in MS results from a silent and progressive atherosclerotic process that started in the first decade of life that could be stopped or at least delayed if identified.

In addition, thrombosis markers, such as fibrinogen, IL (6,8, 1 B), TNF-α, monocyte chemotactic protein-1 (MCP-1) and PAI-1 have elevated levels in obese youngsters with MS.

Up until very recently, only necropsy studies warned about the beginning of atherogenesis early in life, and non invasive techniques have attested to this sequence of events.

Ultrasound of the neonatal and fetal aorta have indicated that retardation of fetal growth, *in utero* exposure to hypercholesterolemia and maternal smoking habits, in addition to diabetic macrossomia may also contribute as risk factors for CVD.

Endothelial function may be investigated invasively or non-invasively by means of various techniques, in several vascular sites and by diverse pharmacological or mechanical stimuli. The non invasive technique most frequently used clinically, involves capturing images by high resolution ultrasound after stimulation determined by ischemia induced by brachial artery occlusion (reactive hyperemia test). A similar non invasive ultrasound technique is used to evaluate the vascular structure by measuring the thickness of the intima media layer of the common carotid (IMCC). Larger IMCC thickness has been observed in youngsters with traditional risk factors for CMD, such as obesity, dyslipidemia and hypertension.

Another study of our group was conducted in 128 adolescents (age 14.6 ± 2.7 years, BMI z score 1.9 ± 0.8). The IMCC thickness was measured and the reactive hyperemia test performed. We found a statistically significant positive correlation between BMI and reactive hyperemia test. Levels of soluble intercellular adhesion molecule (sICAM-1), soluble vascular cell adhesion molecule (sVCAM-1) and PAI-1 was also measured and the it was found positive association between abdominal obesity and sVCAM-1 and also with adiposopathy (defined as the presence of three or more adipocitokines such as IL-6, FNT-α, CRP, leptin and high molecular weight adiponectin) and sICAM-1 confirming the hypotheses of early onset of the atherosclerotic process.

Although atherosclerosis is clinically manifested in adult life, it is clear that a long and asymptomatic phase precedes its development. Apparently it begins in childhood and there are evidences in populations of developed and developing countries that the proinflammatory state and OS are triggers for atherogenesis. Therefore, in order to be effective, primary prevention of CVD must occur in this age group, especially in those with excessive weight. Even more important is the fact that the major determinant of both inflammation and OS is abdominal obesity, which constitutes a risk factor believed to be modifiable, therefore, intervention is recommended, and with adequate control its consequences are reversible.

2.3 Insulin resistance and carbohydrate metabolism disorders

Insulin plays a vital role in glucose metabolism and energy homeostasis. Its action depends on two basic factors: pancreatic secretion and tissue sensitivity. Peripheral insulin sensitivity is responsible for glucose uptake (by the muscle) and for suppression of glucose production (by the liver).

IR occurs when a defined quantity of insulin produces a subnormal biologic response, more specifically, it is characterized by reduction in the ability of insulin to stimulate the use and uptake of glucose by peripheral tissues and suppress hepatic glyconeogenesis. As an anabolic and mitogenic hormone, insulin acts on stimulating the synthesis of glycogen, FFA, TG and proteins and also in reducing proteolysis and lipolysis.

One of the major consequences of obesity is IR, and is almost a consensus that it represents the link between some cardiovascular and metabolic risk factors in both, adults and youngsters. There is also association between this state and the polycystic ovary syndrome, nonalcoholic fatty liver disease, obstructive sleep apnea and some specific types of cancer.

Fasting insulinemia is not a good marker for IR diagnosis, due to the lack of standardization among the tests and non definition of normal values, particularly for youngsters. The gold standard method for the diagnosis of insulin sensitivity in adults as well as children and

youngsters is the hyperinsulinemic-euglycemic clamp, however it is difficult to use clinically. One simple and validated index is the homeostasis model f insulin resistance (HOMA-IR) ([fasting insulin (U/mL)] x [fasting glycemia (mg/dL)]/405). Nevertheless, there is no consensus about the cut-off point for the pediatric population. Keskin and collaborators, after a study with adolescents proposed the value > 3.16.

Glycemia per *se* is an important risk factor for adverse cardiovascular events, and its control leads to cardioprotection, particularly when early intervention is provided. Several studies with strict glycemic control, such as The Diabetes Control and Complications Trial (DCCT) , The Epidemiology of Diabetes Interventions and Complications Study (EDIC) among others confirmed this hypothesis. Various mechanisms have been proposed to explain this relationship: 1. Protein glycation: this process leads to the production of advanced glycation end products (AGE) which, after activation of their receptor (RAGE) in endothelial cells, smooth muscle cells and macrophages, determine both increase in the activation of transcription factors in the vessel that favor atheroma plaque formation, increase in adhesion molecule expression and cytokine secretion; 2. Circulating lipoprotein glycation: potentiates the atherogenicity of LDL-C, thus contributing to atherogenesis; and 3. Direct effect glucose on the vascular wall: contributes to endothelial dysfunction by increasing adhesion molecule expression, reducing plasminogen activator production and increasing PAI-1 production, generating a hypofibrinolytic and inflammatory state

3. Metabolic syndrome

3.1 Epidemiology

Since 1970, in the United States, the prevalence of overweight among children from 2 to 5 years of age has doubled, and among children and adolescents from 6 to 19 years of age, tripled. At present 17% of the pediatric population is overweight. In Brazil the panorama is no different, with growing rates ranging between 4.4% and 33.6%, depending on the methodology used for defining obesity and the characteristic of the sample studied. It is always important to remember that biological, social, cultural and economical factors are involved in the development of obesity and Brazil is a country with heterogeneous characteristics in terms of these factors. The Brazilian Institute of Geography and Statistic in 2012 showed rate of 10% of overweight and 7.3% of obesity among children and adolescents. An epidemiologic study conducted with 699 children in Feira de Santana, BA, has confirmed this fact by finding prevalence of 8.6%, 9.1% and 4.4% of underweight, overweight and obese children, respectively as already mentioned.

In this same population blood pressure levels were analyzed and even at a mean age of 7.1 years, 3.6% of the sample presented elevated arterial pressure, with an odds ratio of 4.4 and 13.0 higher for those who were overweight and obese respectively.

Data obtained from the four largest regions in the world (United States of America, Latin America, Europe and Asia) reinforce the importance of MS in the pediatric population because it affects individuals of both sexes, in the major ethnic groups, but above all, those who are overweight.

The estimated prevalence of MS among individuals aged 2 to 19 years is ~10% (1,2% to 22,6%), from ~2% among children and adolescents with normal weight and ~32% among the obese, but with prevalence of up to 60% in this special group. Thus the odds of presenting MS is 15 times higher among overweight youngsters when compared with individuals of normal weight. The information with regard to sex is conflicting, but there is

a trend towards higher prevalence among men, because they have greater predisposition for abdominal obesity. Age is another factor that must be taken into consideration, and adolescents are affected to a larger extent than children.

The National Health and Nutrition Examination Survey (NHANES) was the population study that analyzed ethnic differences, and it pointed out a higher rate of MS among Caucasians, and a lower rate among Afro-Americans. This fact is surprising, since the outcomes of MS (acute myocardial infarction and DM2) are more frequent among Afro-Americans, probably due to greater IR found among the youngsters in this ethnic group.

Nevertheless, this IR is initially compensated by increased insulin secretion and clearance, consequently with less risk of MS. As the increased insulin secretion probably precedes the state of IR, this high level of insulin, plays a fundamental role in the physiopathology of the syndrome. Hyperinsulinemia and IR are linked to endothelial dysfunction (ED) in adults, a relationship between HOMA-IR and IMCC thickness.

In Brazil the prevalence of MS among youngsters is very similar to that in developed countries, particularly among the obese. A study conducted with 548 school children in Feira de Santana, BA, with a mean age of 11.1 years, showed a prevalence of 31.3% among those who were overweight (BMI z score > 1.5). Abdominal obesity was the most frequent traditional component of MS found in the total sample (68.3%) confirming the fundamental role of visceral AT accumulation in development of the syndrome. This was followed by hypertriglyceridemia (29.3%), reduction in HDL-C (28.4%) and elevation of arterial blood pressure (17.4%). Interestingly, no alteration in carbohydrate metabolism was detected, in spite of the oral glucose tolerance test having been performed for diagnosis of carbohydrate metabolism disorders. Another study, also conducted in the Brazilian northwest confirmed the association between overweight and diagnosis of the syndrome, with rates of 22.6% and 59.3% in the total sample and in the obese subgroup, respectively. An analysis of 99 adolescents in the southeast of Brazil demonstrated a lower prevalence of the syndrome (6%) and also no cases of it were observed among those with normal weight and overweight (BMI z score > 1.5 and < 2.0). Nevertheless, among the obese (BMI z score > 2.0), the rate increases to 26.1% and once again, no cases of carbohydrate metabolism disorders were detected. Thus, the Brazilian data with regard to the component "glucose metabolism disturbance" of MS, diverge from those in the literature, particularly the North American data, which point towards and increase in the rates of pre-diabetes and DM2 in the obese pediatric population. The possible causes of this divergence, apart from the non uniformity of diagnostic criteria for the syndrome, would be the lower severity of obesity in the Brazilian population, which is a recognized factor for the development of alteration in glycid metabolism, in addition to the probable presence of protective genetic and environmental factors.

This epidemiologic profile indicates that obese youngsters must be considered at risk for cardiometabolic diseases and therefore considered targets for preventive and therapeutic strategies. However, in developing countries it has been suggested that screening for MS should also be done in normal weight individuals if the objective is prevention of CVD and DM2, because, in the same way as with obese individuals, this population may present disorders linked to metabolism and the cardiovascular system.

3.2 Definition, diagnosis and clinical importance

MS is defined as a constellation of specific anthropometric, physiological and biochemical abnormalities that predispose affected individuals to the development of CVD and DM2, described in adults in 1988 by Reavan and collaborators.

In youngsters the non existence of a universally accepted definition for the diagnosis of the syndrome is recognized, probably because of the dynamic aspects related to growth and development, and it is a real barrier. For example, individuals develop IR during puberty, and the normal levels of lipids and arterial blood pressure vary according to age and sex.
Another complicating factor is the absence of standardization of the measurement of abdominal obesity, as well as its cut-off points. Thus, the criteria used for defining MS in the pediatric population are adaptations of criteria used for adults, and none of them are widely accepted. Nevertheless, the majority of them include the following elements: 1. Elevation of TG; 2. Reduction in HDL-C; 3. Increase in arterial blood pressure; 4. Alteration in plasma glucose; and, 5. Increase in abdominal obesity.
Based on data from NHANES III (1988 - 1994), Cook and collaborators have suggested a definition adapted from the criteria defined by the National Cholesterol Education Program - Adult Treatment Panel III, NCEP/ATP-III), since Ferranti and collaborators, in spite of proposing definition also based on the NCEP/ATP-III criteria, used different cut-off points for each criteria. A study conducted at the School of Medicine of Yale University by Weiss and collaborators, used another criterion, replacing WC used in the previously described definitions, by the BMI, because they proved this index to be less subject to variations resulting from age and ethnic group (Table 1).

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Criteria / components	**Cook et al.**	**de Ferranti et al.**	**Weiss et al.**
Abdominal obesity	WC[1] > 90[th] percentile	WC[1] > 70[th] percentile	z (BMI)[6] > 2
Glycid metabolism	FG[2] > 110 mg/dL	FG[2] > 110 mg/dL	Glycemia (OGTT[7]) of 140 to 200 mg/dL
Dyslipidemia	TG[3] > 110 mg/dL or HDL[4] > 40 mg/dL	TG[3] > 110 mg/dL or HDL[4] > 45 mg/dL (men) and < 50mg/dL (women)	TG[3] > 95[th] percentile or HDL[4] < 5[th] percentile
Arterial hypertension	BP[5] > 90[th] percentile	BP[5] > 90[th] percentile	BP[5] > 95[th] percentile

*WC = waist circumference; 2FG = fasting glycemia; 3TG = triglycerides; 4HDL-C = high density cholesterol; 6z BMI = z score of body mass index; 7 OGTT = oral glucose tolerance test; 8 BP = blood pressure.
Source: Adapted from Pergher et al (2010).

Table 1. Criteria for classification of the metabolic syndrome in children and adolescents, proposed by Cook et al., de Ferranti et al. and Weiss et al. in the presence of at least three of the five criteria

The organizations, NCEP/ATP, World Health Organization and IDF have suggested criteria for the child and young population based on the criteria proposed for the adult population (Table 2). The new IDF definition is interesting as it divides the groups according to age: from 10 to 16 years and over 16 years, children under the age of 10 years being excluded due to the non existence of data related to this age range. The authors also suggested that in children under the age 6 - 10 years the syndrome should not be diagnosed, but that the need for weight reduction must be emphasized in those with abdominal obesity. For children over the age of 10 years, the syndrome is diagnosed by the presence of abdominal obesity, defined by the WC measurement, associated with two or more clinical criteria (hypertriglyceridemia, low levels of

HDL-C, AH and hyperglycemia). For the other factors, cut-off points were established by means of a fixed value, which in truth, is contrary to the other proposals for child and young populations. Nevertheless, the use of percentiles is also criticized, particularly in the transition to the adult stage, since the cut-off points for the criteria for this population are fixed and not based on percentiles. Thus, when an individual aged 18 years is analyzed using the fixed cut-off points and those based on the percentile tables, there may be a difference in the diagnosis.

As there is increasing prevalence of childhood obesity, as well as other risk factors for CVD and DM2, it has become necessary to conduct studies for standardizing criteria that are simple to apply for the diagnosis of MS in the child and young populations. Early diagnosis followed by treatment, which up to now has been directed towards individual components of the syndrome, particularly intervention in lifestyle, is fundamental for reducing the progression of MS rates in children and adolescents.

Over the last decade questions have arisen about the real existence of the syndrome, especially in the child and young populations, in terms of whether the syndrome represents a distinct clinical entity, or only a constellation of factors linked to obesity, occurring in the same individual, since its diagnosis does not aggregate greater risk of cardiometabolic disease than its components evaluated individually (visceral obesity, dyslipidemia, AH, alteration in carbohydrate metabolism and IR). In a concrete manner, however, there are: 1. Alarming data on the prevalence of the syndrome and the relationship between its components and cardiometabolic complications at a very early age, with thickening of the IMCC layer and atherosclerotic lesions in the arterial network; 2. Information that confirms that the diagnosis of overweight and MS in childhood are predictors of MS and its consequences in the adult population; 3. Relationship between MS and DM2 in adult life and similar association in children and adolescents; 4. Association between this syndrome in childhood and other disorders, including hyperuricemia, HE, polycystic ovary syndrome and obstructive sleep apnea; and 5. That it has been accepted as a simple clinical instrument for the early detection of DM2 and ACVD and individuals at risk for these conditions.

In addition to all these affirmations, the recognition of a probable physiopathological basis linked to visceral obesity/IR as a link between the components of MS, enables the clinician to have a broader vision of the risks of excess AT, even in very young individuals, thus changing his/her practical conduct, by systematic investigation of the factors that constitute the syndrome and its consequences. Thus, preventive and therapeutic measures are adopted earlier, thereby reducing the chance of development of cardiovascular outcomes.

Nevertheless, it is worth emphasizing that there is no consensus about the benefits of diagnosing MS in the pediatric population, and future studies will probably be developed with the aim of establishing which individual component of MS creates the greatest future risk and should be the target for therapy.

1. National Cholesterol Education Program - Adult Treatment Panel III: modified criteria for children and adolescents

Definition of MS: presence of three or more of these conditions (A-B-C-D-E):

A	FG1	> 110 mg/ dL (6.1 mmol/L) or >100 mg/ dL (5.6 mmol/L)
B	WC2	> 90th percentile of sample distribution
C	TG3	> 110 mg/ dL (1.13 mmol/L)
D	HDL-C4	< 40 mg/ dL (1.04 mmol/L)
E	BP5	> 90th percentile of sample distribution

2. International Diabetes Federation (IDF) criteria for children and adolescents

Definition of MS: presence of central obesity (A) in addition two or more of the conditions (B-C-D-E)
Criteria according to age

		6 to <10 years of age	10 to 16 6 to <10 years of age	16 years of age
A	WC2	MS cannot be diagnosed, but future evaluation must be made if there is presence of family history of MS, DM2, dyslipidemia, cardiovascular disease, hypertension and / or obesity.	> 90th percentile	Use existing IDF criteria for the adult population
B	TG3		> 150mg/ dL (1.7mmol/L)	
C	HDL-C4		< 40 mg/dL (1.03 mmol/L)	
D	BP5		Systolic BP5 >130 mmHg or Diastolic BP5 > 85 mmHg	
E	FG1 or previous diagnosis of diabetes mellitus type 2 (DM2)		>100 mg/dL (5.6 mmol/L)	

3. World Health Organization (WHO) criteria modified for children and adolescents

Definition of the MS: presence of three of more of these conditions (A-B-C-D-E):

A	BMI6	> 95th percentile
B	Abnormal Glucose Homeostasis	Hyperinsulinaemia or IFG7 or IGF8
C	BP5	> 952th percentile
D	TG3	> 105/136 mg/dL (1.2/1.5 mmol/L) for children aged <10 years and > 10 years respectively
E	HDL-C4	< 35 mg/ dL (0.9 mmol/L)

[1]FG = fasting glycemia [2]WC = waist circumference; [3]TG = triglycerides; [4]HDL-C = high-density cholesterol; [5]BP = blood pressure, [6]z BMI = z score of body mass index. Source: Adapted from Tailor et al. (2009).

Table 2. Summary of the Metabolic Syndrome (MS) definitions used in the studies.

4. Conclusions

The prevalence of obesity among youngsters presents epidemic proportions with significant implications for cardiovascular and metabolic health at a very early age in life. There are increasing rates of MS in children and adolescents, which points towards the premature development of CVD and DM2 in the next generation of adults. IR, determined by abdominal obesity appears to represent the link between the components of MS in this age range, and functions as a predictor for CVD and disturbances in carbohydrate metabolism. Therefore, the WC measurement should be considered a screening instrument for the identification of youngsters with a cardiometabolic disease phenotype.

As a consequence of this abdominal obesity-IR binomial, a systemic inflammatory state is produced, which functions as a trigger for the atherogenic process. The earlier the onset of overweight, the more prematurely this will manifest clinically. Therefore, in order to implement primary prevention of CMD, investigation/prevention/treatment of risk factors, such as obesity, dyslipidemia, AH and disturbances in carbohydrate metabolism and its consequences must begin in the initial stages of life.

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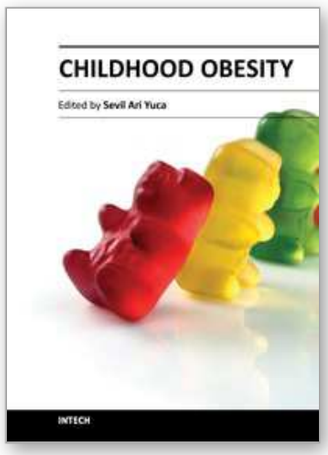

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This book aims to provide readers with a general as well as an advanced overview of the key trends in childhood obesity. Obesity is an illness that occurs due to a combination of genetic, environmental, psychosocial, metabolic and hormonal factors. The prevalence of obesity has shown a great rise both in adults and children in the last 30 years. It is known that one third of children who are obese in childhood and 80% of adolescents who are obese in their adolescent years continue to be obese later in life. Obesity is an important risk factor in serious illnesses such as heart disease, hyperlipidemia, hyperinsulinemia, hypertension and early atherosclerosis.

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