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LEFT VENTRICULAR REMODELING PATTERNS IN CHILDREN WITH METABOLIC SYNDROME

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Keywords: metabolic syndrome, children, left ventricular remodeling patterns.

Introduction. *Pathological left ventricular (LV) remodeling in children with metabolic syndrome (MS) is associated with a significant increase in cardiometabolic risk. However, data regarding the prevalence of LV remodeling patterns in children with MS are limited.*
Material and methods. *An observational analytical cohort study was conducted on 145 children. The diagnosis of MS was established according to the International Diabetes Federation (IDF) criteria. We analyzed the echocardiography, as well as clinical and paraclinical data. Participants were distributed, depending on LV mass index and relative wall thickness into four LV geometric patterns as recommended by American and European Society of Echocardiography: normal geometry, concentric left ventricular remodeling (cLVR), concentric left ventricular hypertrophy (cLVH), and eccentric left ventricular hypertrophy (eLVH).*
Results. *The pathological remodeling patterns were distributed as follows: 62.1% (n=90) participants showed a normal LV geometry pattern, 27.6% (n=40) – cLVH, 5.5% (n=8) – cLVR and 4.8% (n=7) – eLVH. In terms of presence/absence of MS, 54.7% (n=29) participants from the research group showed a normal LV geometry pattern, 32.1% (n=17) – cLVH, 5.7% (n=3) – cLVR and 7.5% (n=4) – eLVH, whereas 66.3% (n=61) participants from the control group presented normal LV geometric appearance, 25% (n=23) – cLVH, 5.4% (n=5) – cLVR and 3.3% (n=3) – eLVR (χ2=0.52; p>0.05).*
Conclusions. *Concentric left ventricular hypertrophy was the commonest LV geometric pattern among the subjects with metabolic syndrome. Concentric left ventricular remodeling and eccentric left ventricular hypertrophy were rare among the study population.*

Cuvinte cheie: sindrom metabolic, copii, modele de remodelare a ventriculului stâng.

MODELE DE REMODELARE VENTRICULARĂ STÂNGĂ LA COPIII CU SINDROM METABOLIC
Introducere. *Remodelarea patologică a ventriculului stâng (VS) la copiii cu sindrom metabolic (SM) este asociată cu o creştere semnificativă a riscului cardiometabolic. Cu toate acestea, date privind prevalenţa paternelor de remodelare ale VS la copiii cu SM sunt limitate.*
Material şi metode. *Studiu analitic, observaţional, de cohortă. Au fost incluşi 145 de copii. Diagnosticul de SM a fost stabilit conform criteriilor Federaţiei Internaţionale de Diabet (FID). Am analizat datele clinice, paraclinice şi ecocardiografice. Participanţii au fost stratificaţi în patru tipare geometrice, folosind indicele de masă a VS şi grosimea relativă a PPVS, aşa cum recomandă Societatea Americană şi Europeană de Ecocardiografie: geometrie normală VS, remodelare concentrică VS (RC VS), hipertrofie concentrică VS (HC VS) şi hipertrofie excentrică VS (HE VS).*
Rezultate. *Tipurile de remodelare patologică s-au repartizat în felul următor: 62.1% (n=90) participanţi au prezentat aspect geometric normal al VS, la 27,6% (n=40) dintre ei s-a înregistrat HC VS, la 5,5% (n=8) participanţi s-a atestat RC VS, iar 4,8% (n=7) din acest lot au prezentat HE VS. În funcţie de prezenţa/absenţa SM, în lotul de bază, 54,7% (n=29) participanţi au prezentat aspect geometric normal, la 32,1% (n=17) a fost înregistrată HC VS, 5.7% subiecţi (n=3) au manifestat RC VS, iar 7,5% (n=4) au prezentat HE VS, iar în lotul de control – la 66,3% (n=61) participanţi s-a atestat aspect geometric normal al VS, 25% (n=23) au prezentat HC VS, în 5,4% (n=5) cazuri s-a determinat RC VS, iar 3,3% (n=3) participanţi au prezentat HE VS (χ2=0,52; p>0,05).*
Concluzii. *Hipertrofia concentrică VS a fost cel mai frecvent model geometric al VS în rândul subiecţilor cu sindrom metabolic, iar remodelarea concentrică VS şi hipertrofia excentrică VS au fost rar depistate în rândul populaţiei din studiu.*

INTRODUCTION

Metabolic syndrome (MS) is considered a recent major health problem, although scientific advances and therapeutic strategies have provided lots of opportunities for its management. It gets even more important if it occurs in children since the therapeutic possibilities in pediatric patients are quite limited due to the considerable side effects and/or no sufficient studies so far.

Metabolic syndrome is a pediatric pathology, leading to several early disorders, including cardiovascular disease (CVD)(1), showing an increased risk due to its early onset and duration. The prevalence rate varies between 10% and 84%, depending on the geographical region, environment, individual demographic characteristics (gender, age, race, and ethnic origin), as well as other criteria used for its defining (2). In terms of gender, most studies show a higher frequency in males (3, 4), whereas the differences also vary depending on the age gaps, being higher in males than adolescent females (10.9% vs 6.29%), subsequently being reversed in adulthood (18% vs 20% at the age of 20-39 years and 42% vs 51% at the age ≤ 60 years) (5).

Pediatric MS correlates with cardiac structural and geometrical changes, leading to a cardiac pathological remodeling, which is considered a substrate for developing heart failure, being also a strong predictor of arrhythmia, characterized by an impaired heart function (systolic and diastolic) and an early risk of sudden death (6).

While considering the aforementioned arguments and the impact of childhood health on further adult health, we considered to choose the following research on left ventricular remodeling patterns in children with MS, that will contribute to the opening of new perspectives for identifying a single and effective approach, as well as for preventing cardiovascular complications of this syndrome, based on IDF criteria adapted for children, to reduce the morbidity and mortality rates at a young age.

MATERIAL AND METHODS

The purpose of the research: to study the left ventricular remodeling patterns in children with metabolic syndrome.

General design and study population. The study project was carried out within the IMPH IMC, at the Department of Pediatrics of the Pediatric Cardiology Clinic, to which 161 children were admitted, aged from 10 to 17 years 11 months and 29 days, from both urban and rural areas, the patients being selected electively during the 2016 – 2019 period. An observational analytical cohort study was planned to achieve the research purpose.

The research comprised several stages. The 1st stage included 145 children (out of 161 participants, 16 ineligible), who were selected based on the inclusion/exclusion criteria, and made up the research group according to *the following criteria*: the age of 10 – 17 years 11 months and 29 days (inclusive); with abdominal obesity (waist circumference (WC) ≥ 90th percentile (7)); the child's parent or guardian consent, as well as children's assent (age ≥ 14 years) on research participation; being a citizen of the Republic of Moldova; ability to effectively communicate with the researcher; ability to understand and follow the study requirements; sufficient understanding in signing the informed agreement and written assent.

The *study exclusion criteria* for the patients were the following: secondary obesity: endocrine, genetic and neurological type, having a suggestive clinical examination, confirmed by specialized examinations; secondary high blood pressure: renal, endocrine, neurogenic, drug - induced, etc., patients having a suggestive clinical examination, confirmed by specialized examinations; acute conditions, whether or not accompanied by fever, whether or not undergoing treatment; chronic respiratory, cardiovascular, gastrointestinal, renal, neurological, endocrine, etc., disorders, whether or not undergoing treatment; the child's parents or legal representative disagreement, child's refusal to participate in the research, with a difficult ultrasound window, low compliance, patient's refusal to be included in the study.

The selected participants underwent a complex examination, which included: filling in a specific questionnaire (food and physical activity survey), the clinical examination on systems, laboratory testing for lipid status (total cholesterol (TCh), triglycerides (TG), high-density cholesterol (HDLc)), the glucose (Glu) spectrum (basal glucose, oral glucose tolerance test (OGTT) – selectively) and uric acid.

Following the clinical and paraclinical findings,

the 2nd stage included the respondent's self-division into 2 groups, by using the criteria of MS according to the Consensus of the IDF adapted for children [1], namely: the research group (L_1) – 53 de children with MS (including 3 – 5 criteria) and control group (L_0) – 92 children without MS (including 1 – 2 criteria). The ratio of the study groups was 1:2. Subsequently, subjects from both groups were investigated by transthoracic echocardiography.

The 3rd stage included a comparative study of the two groups, in terms of lifestyle, symptoms, demographic, anamnestic and biochemical profile, cardiac function and morphology, etc., as well as a statistical analysis of the obtained results. Practical conclusions and recommendations, based on the obtained results, were traced out at the 4th stage of the study.

All the participants were selected and informed about the research stages, being enrolled only by personal informed consent, following a detailed explanation of the requirements and procedures of necessary investigations by discussing with each subject individually. All the procedures were performed, based on children's parent and legal representative consent, as well as on written assent of children ≥ 14 years old. They were not paid and have not suffered any financial costs for participation.

Ethical considerations. The study complied with the international standards of medical ethics, developed by the Declaration of Helsinki, regarding confidentiality and personal data protection of the participants. The research was approved by the Research Ethics Committee of State University of Medicine and Pharmacy *Nicolae Testemitanu* (report no. 59 of 03.06.2016). The resulting data were revealed only to the concerned participant, the personal data of each subject were not used and will not be used for any other purpose. The study applied the following research methods: historical, comparative, biostatistics ones, and others.

Metabolic syndrome. MS was defined according to the IDF consensus definition of metabolic syndrome in children (8): WC≥90th percentile or adult cut-off if lower, plus any two of the following four factors: TG≥1.7 mmol/L, HDLc<1.03 mmol/L, BP systolic ≥130 and diastolic ≥85

mmHg (> 95th percentile for age, height, and sex), Glu≥5.6 mmol/L (If≥5.6 mmol/L (or known T2DM) recommend an OGTT) for age group 10 – <16 years, and use existing IDF criteria for adults: central obesity (defined as WC≥94 cm for Europid men and ≥ 80cm for Europid women, with ethnicity specific values for other groups) plus any two of the following four factors: TG≥1.7mmol/L or specific treatment for high TG, reduced HDLc: <1.03mmol/L in males and <1.29 mmol/L in females, or specific treatment for low HDLc, systolic BP≥130 mmHg or diastolic BP≥85 mmHg or treatment of previously diagnosed Arterial Hypertension, and Glu≥5.6 mmol/L or known T2DM for age group >16 years.

Left ventricular geometry pattern. To define the LV geometry pattern, we measured the myocardial mass index by M-mode echocardiography using the Devereux formula and normalized to height [2,7], as well as the relative wall thickness (RWT) defined as LV wall thickness + septal thickness relative to the internal dimensions of the LV. The LVH was diagnosed by cutoff value utilized in adults (51 g/m) corresponding to the 97.5th percentile in children (9). The LV geometric patterns (normal, eccentric or concentric LV hypertrophy, and concentric LV remodeling) were calculated according to the *left ventricular mass index* (*LVMI*) and RWT. All echocardiographic measurements were conducted using the Toshiba Aplio 300, MODEL TUS-A300 Cardiac Ultrasound Machine, by a specialized sonographer, who was unaware of the patients' diagnosis.

Covariates. Apart from standard biochemical parameters to confirm the diagnosis of MS, uric acid level, and LDLc (TCh - HDLc - TG/5), were determined in every patient. All blood specimens were taken after an overnight fasting. Additional clinical evaluation included medical history, lifestyle questionnaire, anthropometric measurements, physical examination, etc.

Statistical analysis. The data collected from the primary material were introduced into the electronic database, whereas the statistical processing was performed using the Statistical Package for the Social Sciences (SPSS) version 20.

RESULTS

According to the inclusion and exclusion criteria, there was formed a general group, including 145 participants, of which 36.6% (53 pts) children with MS (research group) and 63.4 % (92 pts) children with non-MS (control group). Gender groups were divided into 55.9% boys (81 pts) and 44.1% girls (64 pts) of the total number of enrolled children. MS was present in 39.5% (32 pts) boys vs 32.8% (21 pts) girls, and non-MS in 60.5% (49 pts) boys vs 67.2% (43 pts) girls ($\chi2=0.69$; $p>0.05$).
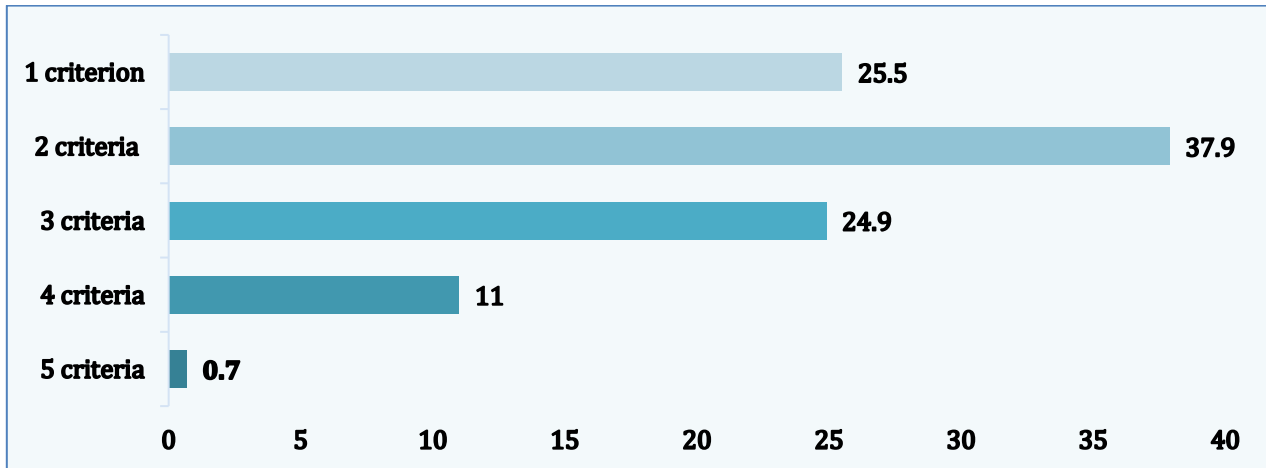

Figure 1. The participant distribution based on the number of criteria and IDF consensus for children (%), n=145.

According to *MS criteria* and based on the IDF agreement, 24.9% (35 pts) subjects presented 3 criteria, 11% (17 pts) – 4 criteria and 0.7% (1 pts) – 5 criteria, whereas 25.5% (37 pts) of the participants presented 1 criterion, and 37.9% (55 pts) – 2 of the mentioned criteria (fig. 1). Gender distribution revealed that 24.7% (20 pts) boys and 25% (16 pts) girls had 3 positive criteria, and 14.8% (12 pts) boys and 7.8% (5 pts) girls – 4-5 criteria for metabolic syndrome ($\chi2=1.77$; $p>0.05$).

Also, there were selected *5 factors of MS* (according to the IDF consensus, adapted for children). The first factor (F1) - obesity, was recorded in 100% (145 pts) of cases in order of prevalence (it might be because children included in the study exhibited WC ≥ 90th percentile), the second factor (F2) found in 47.6% (69 pts) of cases, showed low values of HDLc and the third factor (F3), found in 25.5% (37 pts) of cases, which were defined by high TG was named the lipidic factor. The fourth factor (F4), recorded in 42.8% (62 pts) of cases with high BP values (BP systolic and/or BP diastolic), was called the blood pressure factor, and the fifth factor (F5), reported in 7.6% (11 pts) of cases with higher than normal blood Glu levels, was related to carbohydrate metabolism, is less prevalent.

The assessment of pediatric MS was also performed by detecting the components and their association. The prevalence of cases with defined MS was assessed using *clustering patterns,* which was estimated according to the number of criteria (tab.1).

Cluster WC+HDLc+HBP was found in 10.3% of cases (15 pts), WC+TG+HDLc was registered in 8.3% (12 pts), WC+TG+HDLc+HBP – 7.6% (11 pts), WC+TG+HBP – 5.5% (8 pts) of cases. The clusters WC+HDLc+Glu+HBP and WC+TG+HDLc+ Glu were found to exhibit the same frequency of 1.4% (2 pts), whereas WC+Glu+HBP, WC+TG+ Glu+HBP and CA+TG+HDL+Glu+HBP in 0.7% (1 pts) of cases. Gender-based clustering showed higher rate of WC+HDL+HBP in females vs male 15.6% (10 pts) vs 6.2% (5 pts) ($p<0.01$); higher WC+TG+HDL cluster rate in males vs females 9.9% (8 pts) vs 6.3% (4 pts) ($p<0.01$); high rate of WC+TG+HDLc+HBP cluster in males vs females 9.9% (8) vs 4.7% (3 pts) ($p<0.01$); WC+TG+HBP cluster prevailing in males vs females 8.6% (7 pts) vs 1.6% (1 pt) ($p<0.01$). Obesity cases were found to be associated with dyslipidemia, high BP and glycoregulation disorders (similar data was found in specialized literature among adult population, whereas no data were recorded for pediatric population).

Table 1. The study of metabolic syndrome components, their association, and clustering.

MS, components	Total (no. %)	Gender (no. %) (χ2 = 27.35; p<0.01)	
		Males	**Females**
WC	37 (25.5%)	20 (24.7%)	17 (26.6%)
WC+HBP	23 (15.9%)	19 (23.5%)	4 (6.3%)
WC+Glu	4 (2.8%)	2 (2.5%)	2 (3.1%)
WC+TG	2 (1.4%)	1 (1.2%)	1 (1.6%)
WC+HDLc	26 (17.9%)	7 (8.6%)	19 (29.7%)
WC+Glu+HBP	1 (0.7%)	-	1 (1.6%)
WC+TG+HDLc	12 (8.3%)	8 (9.9%)	4 (6.3%)
WC+HDLc+HBP	15 (10.3%)	5 (6.2%)	10 (15.6%)
WC+TG+HBP	8 (5.5%)	7 (8.6%)	1 (1.6%)
WC+HDLc+Glu+HBP	2 (1.4%)	1 (1.2%)	1 (1.6%)
WC+TG+HBP+Glu	1 (0.7%)	1 (1.2%)	-
WC+TG+HDLc+HBP	11 (7.6%)	8 (9.9%)	3 (4.7%)
WC+TG+HDLc+Glu	2 (1.4%)	2 (2.5%)	-
WC+TG+HDLc+Glu+HBP	1 (0.7%)	-	1 (1.6%)

Note: The values are presented as absolute values (and percentage) for statistically significant categorical data p<0.01; WC – waist circumference; TG – triglyceride; HBP – high blood pressure values; Glu – glucose; HDLc – high-density cholesterol.

The results of the selective analysis of some anthropometric parameters. The studied groups were characterized by the following values (tab.2): 80.5±2.05 kg in the study group vs 73.4±2.3 kg in the control group, with the statistical difference (p<0.01); the height, values were 168.4±1.7 cm in MS group, and 161.4±1.5 cm in non-MS group, with a true statistical difference; the mean BMI index showed absolute values in the study group – 28.2±0.4 kg/m², and in the control group 27.1±0.5 kg/m² (p>0.05), according to the percentiles – 94.7±0.6 vs 93.9±0.4 (p>0.05), and according to the Z score both groups had the same mean value of 1.7±0.05 (p>0.05); the mean values of WC were 94.5±1.2 cm in the MS group and 90.5±1.07 cm in the control group (according to the percentiles, in 100% of WC cases ≥90th percentile), with a statistically significant difference (p<0.05); hip circumference was 103.5±1.3 cm in children with MS and 98.7±1.3 cm in those with non-MS, with a statistically significant difference (p<0.05); abdominal index – 0.9±0.01 and the waist-to-hip-ratio was higher in the study vs control group 1.88±0.03 m² vs 1,76±0.03 m², but showing no significant statistical difference (p>0.05).

The results of the evaluation of some biochemical parameters. A comparative study between the biochemical indices in children with MS vs non-MS revealed the following mean values (tab.2): TG – 1.97±0.2 mmol/l, compared to 1.16±0.03 mmol/L (p<0.001); TCh – 4.09±0.14 mmol/L, compared to 4.06±0.09 mmol/L (p>0.05); HDLc – 1.03±0.03 mmol/L vs 1.33±0.03 mmol/L (p<0.001); LDLc – 2.11±0.12 mmol/L vs 2.05±0.17 mmol/L (p<0.001); LDLc/HDLc – 2.04±0.04 mmol/L vs 1.54±0.05 mmol/L (p<0.001); TCh/HDLc – 3.97±0.01 mmol/L vs 3.05±0.01 mmol/L (p>0.05); ß-lipoproteins 45.15±1.78 mmol/L, compared to 46.74±1.21 mmol/L (p>0.05) and uric acid – 315.41±10.65 mmol/L, compared with 292.88±8.56 mmol/L (p>0.05).

The results of the evaluation of the types of remodeling of the left ventricular myocardium (fig.2). The distribution of LV remodeling types was carried out as recommended by the American and European Society of Echocardiography, based on the mea-surements of LVMI and RWT. The types of pathological remodeling were distributed as follows: 62.1% (n=90) participants showed a normal geometry pattern of LV, 27.6% (n=40) – concentric LV hypertrophy, 5.5% (n=8) – concentric LV remodeling, and 4.8% (n=7) – eccentric LV hypertrophy.

In terms of presence/absence of MS, 54.7% (n=29) participants from the research group showed a normal LV geometry pattern, 32.1% (n=17) – concentric LV hypertrophy, 5.7% (n=3) – concentric LV remodeling and 7.5% (n=4) – eccentric LV hypertrophy, whereas 66.3% (n=

61) participants from the control group presented normal LV geometric appearance, 25% (n=23) – concentric LV hypertrophy, 5.4% (n=5) – concentric LV remodeling and 3.3% (n=3) – eccentric LV hypertrophy (χ2=0.52; p>0.05) (fig. 3).

Table 2. The values of some anthropometric and biochemical parameters in children included within the research.

Variables (M±m)	MS	non-MS	p-value
Weight, M±m, (kg)	80.5±2.05	73.4±2.3	<0.01
Height, M±m, (cm)	168.4±1.7	161.4±1.5	<0.01
BMI, M±m, (kg/m²)	28.2±0.4	27.1±0.5	SI
BMI, M±m, (percentiles)	94.7±0.6	93.9±0.4	SI
BMI, M±m, (Z score)	1.7±0.05	1.7±0.05	SI
WC, M±m,(cm)	94.5±1.2	90.5±1.07	<0.05
HC, M±m,(cm)	103.5±1.3	98.7±1.3	<0.05
WHR, M±m,	0.9±0.01	0.9±0.01	SI
AI, M±m,	0.6±0.01	0.6±0.01	SI
BSA (m²) M±m,	1.88±0.03	1.76±0.03	SI
TG (mmol/l)	1.16±0.03	1.97±0.2	<0.001
TCh (mmol/l)	4.06±0.09	4.09±0.14	SI
HDLc (mmol/l)	1.33±0.03	1.03±0.03	<0.001
LDLc (mmol/l)	2.05±0.17	2.11±0.12	<0.001
TCh/HDLc	3.05±0.01	3.97±0.01	SI
LDLc/HDLc	1.54±0.05	2.04±0.04	<0.001
ß-lipoproteins (mmol/l)	46.74±1.21	45.15±1.78	SI
Uric acid (mmol/l)	292.88±8.56	315.41±10.65	SI

Note: Values are presented as mean ± standard deviation for a number of values; SI – statistically insignificant (p>0.05); the value of p<0.05 = considered significant; the value of p<0.001 = considered significant; BSA – body surface area; AI – abdominal index; WHR –waist-to-hip-ratio; HC – hip circumference; WC – waist circumference; BMI – body mass index; TG – triglycerides, TCh – total cholesterol, HDLc – high density cholesterol, LDLc – low density cholesterol
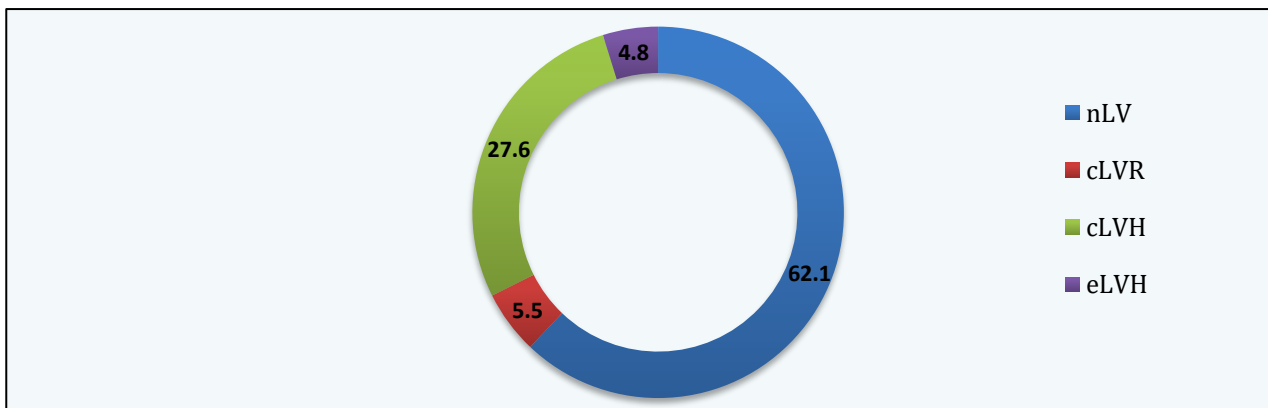

Figure 2. Left ventricular remodeling patterns (%).

Note: nLV – normal LV appearance, cLVR – concentric LV remodeling; cLVH – concentric LV hypertrophy; eLVH – eccentric LV hypertrophy.

The gender-related distribution revealed the following results in boys: 63.4% (n=52) – normal LV geometric appearance, 24.4% (n=20) – concentric LV hypertrophy, 4.9% (n=4) – concentric LV remodeling and 7.3% (n=6) – eccentric LV hypertrophy and in girls: 60.3% (n=38) – normal LV geometric appearance, 31.7% (n=20) – concentric LV hypertrophy, 6,3% (n=4) – concentric LV remodeling and 1.6% (n=1) showed eccentric LV hypertrophy (χ2=0.34; p>0.05).

Depending on the number of MS criteria, a normal LV geometry appearance was found in

25.8% (n=24) of MS children with 1 positive criterion, 38.7% (n=37) – 2 criteria, 24.2% (n=21) – 3 criteria and in 11.3% (n=8) cases with 4-5 criteria. Concentric LV remodeling was recorded in 10% (n=1) subjects with 4-5 MS criteria, and in 30.0% (n=2) of cases with 1, 2 and 3 criteria. Concentric LV hypertrophy was recorded in 15.2% (n=8) of MS children with 1 positive criterion, 27.3% (n=15) – 2 criteria, 32.6% (n=11) – 3 criteria and 24.9% (n=6) – 4-5 criteria. Eccentric LV hypertrophy was found in 11.7% (n=1) of MS children with 1 positive criterion, 19.1% (n=2) – 2 criteria, 27.9% (n=1) – 3 criteria and 41.3% (n=3) – 4-5 criteria ($\chi2=3.58$; $p>0.05$) (fig. 4)
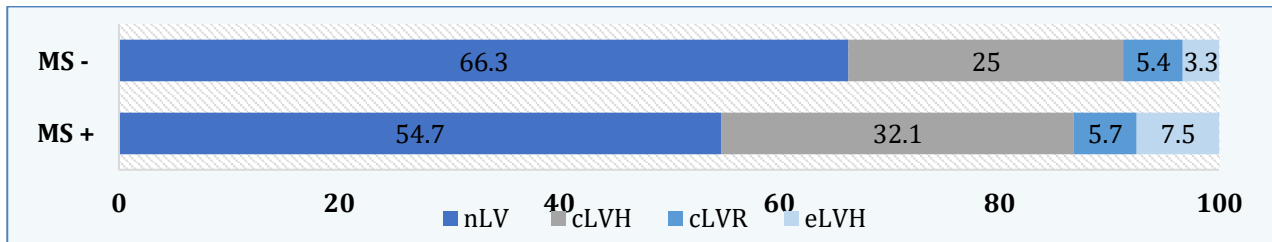

Figure 3. Left ventricular remodeling patterns depending on the presence/absence of metabolic syndrome.

Note: nLV – normal LV appearance, cLVR – concentric LV remodeling; cLVH – concentric LV hypertrophy;eLVH – eccentric LV hypertrophy.
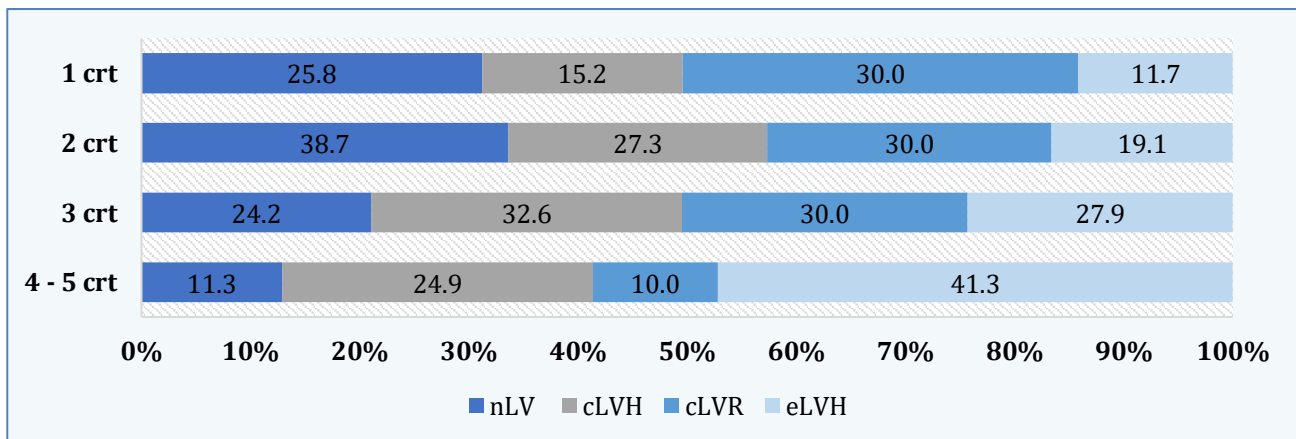

Figure 4. Left ventricular remodeling patterns depending on the number of MS criteria and according to IFD Consensus for children.

Note: nLV – normal LV appearance. cLVR – concentric LV remodeling; cLVH – concentric LV hypertrophy; eLVH – eccentric LV hypertrophy.

According to MS clustering, concentric LV remodeling was recorded in 15% (n=1) of subjects with WC+TG+HBP, WC+HDLc+HBP and WC+HDLc+TG+HBP clustering patterns. Eccentric LV hypertrophy was recorded in 14.7% (n=1) of participants with WC+HDLc+HBP, WC+HDLc+TG+HBP+Glu and 27.9% (n=2) of subjects with WC+HDLc+TG+HBP cluster patterns. Concentric LV hypertrophy was found in 18.7% (n=6) of participants with WC+HDLc+HBP clusters, 6.1% (n=4) of cases with WC+TG+HBP and WC+TG+HDLc+HBP and in 1.6% (n=1) – WC+TG+HDLc, WC+TG+Glu+HBP, WC+TG+HDLc +Glu. The LV with normal geometric appearance had a different overall distribution, being registered in all clinical patterns ($\chi2=11.96$; $p>0.05$).

The risk for installing of left ventricular myocardial remodeling. During the research, the risk of installing the LV myocardium remodeling patterns in children with MS has also been determined, initially being formed as "table 2x2", afterwards the necessary indicators were calculated and the obtained results were interpreted. Respectively, RR (relative risk) = 1.7 was obtained, ranging between 1.7 – 2.5, which was considered a moderate risk. Thus, MS is a risk factor for the development of LV myocardium remodeling, whereas taking into account that

confidence interval (CI) does not include value 1 (CI is between 1.3 and 4.2) it can be concluded that there is a positive association between these two.

DISCUSSIONS

MS is a clinical condition, which is associated with an increased risk of cardiovascular diseases (10). The present study investigated a well-defined general population, aged between 10–18 years, the prevalence of the MS and that of its contributors, as well as the relationship with non-invasively measured markers of cardiac involvement.

The syndrome was found to have a considerable prevalence in the pediatric population, averaging 36.6% of all subjects aged between 10-18 years, showing greater prevalence among boys (39.5% vs 32.8%), which was similar to previous studies (10).
Regarding the MS-related factors, apart from visceral adiposity present by definition in 100% of cases, high TG (25.5%), high BP (42.8%), and low HDLc (47.6%) values were the most frequently detected.

The assessment of pediatric MS was also performed by detecting the components and their association. The prevalence of cases with defined MS was assessed by using the clustering patterns, being estimated according to a number of criteria. The clusters WC+HDLc+HBP, WC+TG+ HDLc, WC+TG+HDLc+HBP, WC+TG+HBP were the most frequently registered. Obesity cases were found to be associated with dyslipidemia, high BP, and glucose regulation disorders (similar data were found in specialized literature among the adult population, whereas no data were recorded for the pediatric population).

In our study, MS subjects-compared to non-MS had significantly higher values of weight, waist circumference, hip circumference, triglycerides,

as well as lower levels of HDL-cholesterol. The anthropometric and biochemical data altogether are the most important features of metabolic syndrome in this present research.

The analysis of cardiac remodeling types showed a higher incidence in pediatric subjects with normal LV geometric appearance – 62.1%. The three pathological LV remodeling subtypes (eccentric hypertrophy, concentric hypertrophy, and concentric remodeling) showed a higher rate for concentric LV hypertrophy – 27.6%, followed by concentric LV remodeling type – 5.5% and eccentric LV hypertrophy – 4.8%, which was predominantly found in males, for three positive criteria, and within the following clusters WC+HDLc+HBP, WC+TG+HDLc, WC+TG+HDLc+ Glu, WC+TG+ HDLc+HBP, showing no statistically significant difference (p>0.05; similar data were found in specialized literature among the adult population, whereas no data were recorded for pediatric population).

Finally, during the research, the potential risk of installing remodeling patterns of LV myocardium in children with MS was also estimated, after calculating the necessary indicators. The syndrome was found to be a risk factor, as well as an association between MS and remodeling of the LV myocardium, which has been identified.

Some limitations of this study must be taken into account. The current study included a relatively small number of patients, particularly of subjects aged between 16-18 years, although metabolic syndrome is considered to have a high incidence rate. The main study limitation regarding the patients'enrollment was the fact that we aimed at identifying pediatric subjects with MS from within the Cardiology Clinic. Another reason for a relatively small number of participants was the careful selection of patients, as to obtain an optimal ultrasound window, for an accurate analysis of the echocardiographic data. The short-term MS installation is another study limitation.

CONCLUSIONS

1. According to the International Diabetes Federation definition, 24.9% of the subjects presented 3 criteria, 11% – 4 criteria and 0.7% – 5 positive criteria (25.5% – 1 criterion, and 37.9% – 2 criteria) for metabolic syndrome. Waist circumference ≥ 90th percentile was recorded in 100% of cases, high densi ty cholesterol value <1.03 mmol/L/1.29 mmol/L – in 47.6%, triglyceride value ≥1.7 mmol/L – in 25.5%, systolic blood pressure value ≥130 mmHg/diastolic blood pressure ≥85 mmol/L – in 42.8%, and glucose values ≥5.6 mmol/L – in 7.6%.

2. The analysis of cardiac remodeling types showed a higher incidence in pediatric subjects wi th nor

mal left ventricular geometric appearance – 62.1%. The three pathological remodeling subtypes (eccentric hypertrophy, concentric hypertrophy, and concentric remodeling) showed a higher rate for concentric left ventricular hypertrophy – 27.6%, followed by concentric left ventricular remodeling type – 5.5% and eccentric left ventricular hypertrophy – 4.8%.

3. In children aged 10-18 years, metabolic syndrome is a risk factor and has a positive association with the development of left ventricular myocardial remodeling (relative risk=1.7, confidence interval=1.3-4.2).

PRACTICAL RECOMMENDATIONS

1. Screening of the metabolic syndrome is recommended in children with abdominal obesity, aged 10 – 18 years in order to detect those cases, who are at risk of developing complications.

2. Echocardiography is recommended to assess the presence of structural remodeling patterns of left ventricular myocardium, which will allow detecting children with metabolic syndrome and those who are at higher risk for developing cardiovascular complications.

CONFLICT OF INTERESTS

The authors do not declare any conflict of interest.

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