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Effects of the Intermittent Exercise Programs on Lipid Profile and Anthropometric Characteristics at Obese Young Subjects

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Abstract**—**The aim of our research was to evaluate the effects of physical exercise on lipid profile and anthropometric characteristics in young subjects, diagnosed with metabolic syndrome (MS). The study has been developed during 28 weeks on 20 young obese patients which have undertaken an intermittent submaximal exercise program. After 28 weeks of physical activity, the results show significant effects on anthropometric characteristics and serum lipid profile of research subjects. Additionally, the results of this study confirms the major correlation between the variations of intraabdominal adiposity, determined ultrasonographycally, and the changes of serum lipid concentrations, a better correlation than it is used abdominal circumference or body weight index.

Keywords**—**lipid metabolism, adiposity, physical exercise

I. Introduction

METABOLIC Syndrome is characterized by the clustering of cardiovascular risk factors, including insulin resistance, central obesity, elevated blood pressure, and atherogenic dyslipidemia. It is associated with prothrombotic state, endothelial dysfunction and a pro-inflammatory state [1, 2].

The diagnosis of metabolic syndrome (MS) is formulated taking into account several criteria [3, 4, 5, 6]. Thus, according to WHO criteria, the diagnosis of MS requires the presence of three of these five criteria: insulin resistance or fasting glucose level ≥6.1 mmol/L and at least two of the following criteria: abdominal or central obesity and WHR (waist to hip ratio) >0.90 in men and >0.85 in women and/or BMI >30 kg/m2; serum triglyceride level ≥1.69 mmol/L and/or HDL cholesterol <0.9 mmol/L in males and <1.00 mmol/L in females; blood pressure ≥140/90 mmHg or treatment with drugs; microalbuminuria: urinary albumin excretion rate 20 mg/min or urinary albumin/creatinine ratio >3.5 mg/mmol [7]. The criteria of the International Diabetes Federation (IDF) include: central obesity (waist circumference in ≥94 cm in males, ≥80 cm in females) and at least two of the following criteria: fasting plasma glucose≥ 6.1 mmol/L or therapy for type 2 diabetes mellitus; serum triglycerides ≥1.7 mmol/L or therapy for triglyceridemia; HDL-cholesterol level <1.00 mmol/L in males and <1.30 in females; blood pressure ≥130 mmHg systolic and ≥85 mmHg diastolic or drug(s) treatment [8].

Usually, when the abdominal circumference has been used as a diagnosing criterion of metabolic syndrome, only the abdominal adiposity had been taken into account, ignoring the conditions in which fat deposits, depending on their localization, produce pathogenic effects. Thus the effects produced by mesenteric, perirenal, perivascular and epicardial localization of body fat excess is now getting more importance.

Current opinion is that there are a clear difference of risks related to the process of cumulating adipose tissue in different areas of the body (subcutaneous, visceral, abdominal), and the physiopathology at obese or overweight persons is related to the visceral accumulation of body fat rather than to the total amount of excessive overweight, and more important, even if the BMI is kept at normal values, the excess of visceral fatness represent a risk factor for cardiovascular pathology [5, 6, 7, 8].

Half a century before, Vague attested the localization of adipose tissue in relation to the subjects' gender, showing the predominance of fatness at upper extremities on men (android adiposity), while on women the adipose tissue is rather localized at lower extremities (gynoid adiposity) [9].

Controversies related to the impact of fatness distribution on the health have concerned the mechanisms due to which a series of products resulted from adipose secretion are the cause of insulin resistance. Among these we list the increase of the free fatty acids, adipokines, proinflamatory interleukins in parallel with the reduction of some mediators, such as adiponectin [10, 11, 12, 13, 14].

The change of glucose level is usually accompanied by

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modification of the lipid profile, as increasing triglycerides and decreasing HDL cholesterol blood level, due to the negative influence of insulin resistance on the fats plasmatic transport.

The subcutaneous fat doesn't induce any obvious effect at all on the glucose's homeostasis. More, sometimes, diminishing subcutaneous adipose tissue at the limbs' level would apparently contribute to the increasing risk for type 2 diabetes [15,16,17]. Thus, there is an important preoccupation for the validation of various assessment methods regarding adipose tissue, i.e. anthropometric and imagistic measurements.

Anthropometric measurements: waist circumference, measured at the midpoint between the lower border of the ribs and the iliac rest, has been reported to be more closely correlated with the level of intra-abdominal adiposity and associated metabolic than ratio of waist/hip circumferences (WHR) [18]; abdominal sagittal diameter, measured with a carpenter's spirit level placed over the abdomen perpendicular to the length axis of the trunk at the iliac crest level, was closely related to the volume of visceral fat [19]. Ultrasonography and Computed Tomography (CT) measurements of intra-abdominal fat are stronger predictors of health risk than anthropometric measurements; it is a safe, accurate and reproducible method with low cost, representing a potentially useful clinical method for assessing intra-abdominal adiposity and obesity-related health risk [20].

At present there it is generally recognized that that regular physical training have a positive influence on the glucose tolerance and insulin sensitivity, serum lipids constants, arterial tension and fibrinolytic activity on persons diagnosed with MS. Moderate and long-term efforts have proved to be efficient regarding the insulin resistance and serum lipids' profile, even if these effects haven't been accompanied by significant changes of the maximum oxygen consumption (VO2max); endurance trainings performed by older persons in comparison to the younger ones with the same BMI and active mass percentage has led to higher O2 consumption on older subjects, accompanied by an accentuated abdominal fat drop; none the less HDL cholesterol have almost similar increases on both groups, while the serum triglycerides registered an important fall on the older subjects [21, 22, 23].

The identification on younger subjects of a VO2max decrease which precedes the installation of specific insulin resistance manifestations, has led to the idea that the physical condition's alteration by diminishing the physical activity of certain subjects is an important factor in triggering the specific pathological manifestations.

Most of the researches bring incontestable proof about the positive effects the regular physical training has on the metabolic and homeostatic anomalies met at subjects with insulin resistance, changes that are accompanied by variable improvements of body composition and adipose tissue's distribution, leading to the decrease of coronary-related diseases and type 2 diabetes.

The aim of our study was to evaluate the changes of abdominal adipose tissues, determined by ultrasonographyc and anthropometric measurements, and their relationship with lipid profile changes (total cholesterol, triglycerides, LDL cholesterol, and HDL plasma cholesterol concentrations) in young subjects, diagnosed with MS, considering a submaximal and intermittent exercise programs.

II. Material and Methods

The study has been carried out for a period of 28 weeks and included 20 young subjects (male, aged 24.5±2.6yr) diagnosed with MS, who provided written informed consent. The rejection criteria were: antilipidemic medication, significant immobilization, renal or thyroid dysfunction, hepatic inflammatory diseases, recent surgical operations, cardiovascular and neurological diseases. Subjects were instructed to maintain their daily dietary habits for all the research period. The following measurements and tests were carried out, using an accurate protocol: anthropometric, ultrasound and laboratory measurements, before and after the training program

Metabolic Syndrome Assessment

We used the Adult Treatment Panel III criteria, which classifies individuals as having the MS if they record at least 3 of the following 5: (1) men with waist circumference (WC) 102cm or women with 88cm; (2) men with high-density lipoprotein (HDL) cholesterol 40 mg/dL or women with 50mg/dL; (3) triglycerides of 150mg/dL; (4) high blood pressure (systolic blood pressure 130 mmHg or diastolic blood pressure 85mm Hg or on antihypertensive treatment); and (5) fasting glucose of 100 mg/dL [24].

Anthropometric measurements

Height was measured without wearing shoes, using a stadiometer (to the nearest 0.1cm) and weight was recorded, in light clothing, with an electronic weight scale (to the nearest 0.1kg). Abdominal circumference was measured, using a flexible steel tape, to the nearest millimeter, in a horizontal plane at the midpoint between the iliac crest and lower costal margin (palpated in the mid axillary line) after normal expiration without pressure on the skin. BMI was calculated in classical way, dividing the weight (in kilograms) by the square of height (in meters). Values between 25 and 29.9 were assigned to overweight category, and a BMI of 30 or over, to obesity.

Ultrasound measurements

The examination was performed with subjects having a supine position. Intra-abdominal adiposity was estimated measuring the distance between internal surface of the rectus abdominis muscle and the anterior wall of the aorta. The measurement was performed with a 3.5MHz transducer placed on the xiphoumbilical line, 1,5cm above the umbilicus. Each distance was measured from three positions, and each measurement was performed three times. The measurements were done without the compression of the abdominal cavity at the end of a normal exhalation, to avoid the influence of

abdominal wall tension and respiratory status [15, 16].

Laboratory Measurements

Serum lipids (total cholesterol, triglycerides, LDL cholesterol, and HDL plasma cholesterol concentrations) were measured. Cholesterol, triglyceride, and high-density lipoprotein cholesterol levels were determined in the serum by commercially available kits on a LYSA 200 auto analyzer. The determination of cholesterol and triglyceride used an enzymatic colorimetric method. High-density lipoprotein cholesterol was measured by using the direct high-density lipoprotein method. Low-density lipoprotein and very low density lipoprotein cholesterol were calculated according to the formula of Friedewald et al. [25]: LDL cholesterol=cholesterol − [HDL cholesterol + (0.46 × triglycerides)].

Physical Activity Assessment

The subjects performed 45 minutes of intermittent exercise/sessions, 3 sessions/week; the intermittent exercise session consisted in 10 minutes of warm up at 70% MRH, followed by intervals of submaximal effort (7 minutes at 80-85%MHR intensity), and separated by three minutes of recovery periods at 70% MHR; the program ended with 5 minutes of cool-down; in this time intensity of effort was monitored by heart rates telemetric recorded with Suunto Team Monitor.

Statistical analysis

Data are given as the mean ± standard deviation the mean (SD). Initial data have been analyzed in order to determine the differences between parameters, before and after application of physical exercise intervention. The changes were calculated and compared between groups using t-Test: Paired Two Sample for Means. The level of statistical significance was set at 0.05. $p < 0.05$ was considered statistically significant.

III. Results

The data recorded before (baseline) and after the application of physical exercise program are registrated in table I. Towards the results we showed that the subjects have proved significant recovery of serum lipid, anthropometric and ultrasonographyc parameters.

We observed a favorable evolution in all serum lipid parameters: reduction was 0.65±0.03mmol/l ($p<0.001$) for serum total cholesterol and 0.95±0.01mmol/l ($p<0.001$) for LDL cholesterol. HDL cholesterol values increased with 0.18 ±0.07mmol/l ($p<0.002$), serum triglycerides decreased with 0.81±0.1 ($p<0.001$). However, the body weight decreased with 7.55 ± 0.33 Kg ($p=0.001$), body mass index with 4.23±0.45 kg/cm^2 ($p=0.01$) and waist circumference with 7.95±0.10 cm ($p=0.05$). Intraabdominal adiposity, evaluated by ultrasound measurement, decreased with 8.92± 0.22mm ($p< 0.001$).

Nevertheless, body weight decreased with 6.55±0.43Kg ($p=0.001$), body mass index with 3.26±0.56 kg/cm^2 ($p =0.01$) and waist circumference with 7.16±0.15cm ($p=0.05$), intraabdominal adiposity (ultrasound measurement) decreased with 7.92±0.52 mm ($p< 0.001$).

TABLE I
CHARACTERISTIC OF THE RESEARCH GROUP BEFORE AND AFTER THE APPLICATION OF PHYSICAL EXERCISE PROGRAM
LEGEND: BW – BODY WEIGHT; BMI – BODY MASS INDEX; WC – WAIST CIRCUMFERENCE; IAA – INTRAABDOMINAL ADIPOSITY; TC – SERUM TOTAL CHOLESTEROL; HDLC – HIGH DENSITY LIPOPROTEIN CHOLESTEROL; LDLC – LOW DENSITY LIPOPROTEIN CHOLESTEROL; TG – TRIGLYCERIDES.

Parameters	Basal	After physical exercise	p
TC (mmol/l)	5.89±0.05	5.24±0.02	<0.001
LDLC (mmol/l)	3.70±0.07	2.88±0.14	<0.002
HDLC (mmol/l)	0.72±0.07	0.89±0.069	<0.001
TG (mmol/l)	2.87±0.19	2.06±0.17	0.001
BW (kg)	96.7±7.52	89.15±7.19	0.001
BMI (kg/m^2)	30.3±2.21	26.07±2.07	0.01
Wc (cm)	105.84±5.10	97.89±4.0	0.05
IAA (mm)	51.5±2.38	42.58±2.03	<0.001

IV. Conclusion

After 28 months of performing physical activity, we observed an improvement of anthropometric characteristics and serum lipid parameters of subjects included in study, relative to the parameters recorded before starting the physical exercise program. Generally, from the analysis of results it can be observe a favorable evolution of the serum lipids: total cholesterol ($p<0.001$), LDL-cholesterol ($p<0.002$), HDL-cholesterol ($p<0.001$), and triglycerides ($p=0.001$). The same situation was recorded also for anthropometric parameters: body weight (0.001), BMI (0.01), waist circumference (0.05) and intraabdominal adiposity (<0.001).

On the other hand, our study has shown the importance of evaluation of intraabdominal adiposity. The results we have obtained confirms previous studies [16, 17, 26] and prove that there is a major correlation between the variations of intraabdominal adiposity dimensions, determined ultrasonographycally, and the alterations of serum lipid concentrations, a better correlation than the one that use abdominal circumference or body weight index.

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