The Utility of Visceral Adiposity Index in Prediction of Metabolic Syndrome and Hypercholesterolemia

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Metabolic syndrome (MS) is defined as a complex entity that involves the accumulation of cardiovascular and metabolic risk factors represented by: abdominal obesity, insulin resistance, hypertension, dyslipidemia [1]. The presence of MS correlates with the risk of cardiovascular disease in people without diabetes mellitus (DM), as well as those with type 2 DM [2-8].Visceral adipose tissue is an active metabolic organ and abdominal obesity is an independent risk factor for metabolic disorder present in MS [9,10,11], associated with the development of cardiovascular disease and type 2 diabetes in children, adolescents and adults [12-15]. Our findings have shown an association of visceral adiposity index (VAI) with MS in both men and women with prediabetes and diabetes, these findings allow us to conclude that VAI is a simple but effective indicator for estimating the presence of MS among adults.

Keywords: Metabolic syndrome, visceral adiposity index, diabetes, prediabetes, cardiovascular risk

MS is a *multiplex* risk factor that increases cardio-vascular risk compared to the isolated existence of traditional risk factors and association with Type 2 DM determines an additional risk of CV events and mortality [16,17].

The root of these problems is abdominal obesity, which in time becomes the bridge between vascular and metabolic risk, treated as a standalone clinical entity, namely cardio-metabolic risk [18,19].

It is useful to have a potential marker of cardiovascular and metabolic risk because the number of people with cardiovascular risk has reached alarming levels in the last years [20]. Thus, Amato et al., in a study of a European Caucasian population, validated a visceral obesity index defined as the *Visceral Adiposity Index* (VAI). VAI could become an easy-to-use tool in everyday practice that highlights cardiometabolic risk. The VAI formula considers gender (M/F), anthropometric measurements (abdominal circumference, body mass index), biochemical tests (triglycerides, HDL cholesterol).

Experimental part
The aim of the study

The aim of this study is to identify the utility of the visceral adiposity index (VAI) in predicting the presence of metabolic syndrome.

Materials and method

The study was conducted over 3 years (2011-2014) and included patients with diabetes mellitus, prediabetes and subjects without diabetes or prediabetes. The study, epidemiologically, transversally, non-interventionally, was conducted by analyzing 300 subjects divided into three subgroups, as follows: Subgroup 1 included 100 prediabetic patients; Subgroup 2 included 100 patients with type 2 diabetes and subgroup 3 (control) of 100 individuals randomly recruited without diabetes or prediabetes.

In these patients, the following anamnestic data were recorded: age, sex, personal history of diabetes and hypertension. Clinically, the following data were evaluated: weight, height, body mass index (BMI), waist circumference (WC), blood pressure (BP) measurement.

Venous blood was harvested from which the following tests were performed: blood glucose, HbA1c value, total cholesterol, HDL-cholesterol, LDL-cholesterol, tri-glycerides. Oral glucose tolerance test (OGTT) was performed in all patients included in the prediabetes subgroup, who had either glucose-lowering (IFG) or low glucose tolerance (IGT) and all patients without DM or prediabetes (132 patients at who had OGTT, a number of 100 had normal values, the rest of 32 had either prediabetes or diabetes).

The diagnosis of metabolic syndrome was established according to the criteria proposed by IDF, NCEP ATP III, harmonized (2009), requiring at least 3 conditions: WC > 102 cm in men and > 88 cm in women, TG $\geq$150 mg / dL, HDL-c < 40 mg / dL in men and < 50 mg / dL in women, BP $\geq$ 130 / $\geq$ 85 mmHg, fasting glycemia $\geq$ 100 mg / dL.

The calculation of visceral adiposity index (VAI), according to gender, has been achieved by the following formulas, where VAI = visceral adiposity index, WC = waist circumference, BMI = body mass index, TG = triglycerides, HDL = HDL Cholesterol (fig. 1 and 2).

$$\text{Males: VAI} = \left(\frac{WC}{39.68 + (1.88 \times BMI)} \right)$$
$$\times \left(\frac{TG}{1.03} \right) \times \left(\frac{1.31}{HDL} \right)$$

Fig. 1. VAI formula for men

$$\text{Females: VAI} = \left(\frac{WC}{36.58 + (1.89 \times BMI)} \right)$$
$$\times \left(\frac{TG}{0.81} \right) \times \left(\frac{1.52}{HDL} \right)$$

Fig. 2. VAI formula for women

The data obtained was recorded as a Microsoft Excel spreadsheet and analyzed for each of the three groups using Microsoft Excel (Microsoft Corp., Redmond, WA, USA) together with XLSTAT 2014 for Microsoft Excel (Addinsoft SARL, Paris, France) and IBM SPSS Statistics 17.0 (IBM Corporation, Armonk, NY, USA) to analyze the relationships between clinical and paraclinical data of patients. For statistical analysis, the SPSS (Statistical Package for Social Sciences) version 17.0 for Windows was used.

Results and discussions

Each group comprised patients equally divided by age and gender. The decades of age in which the patients of each group were assigned are shown in table 1.

In women, there were statistically significant differences (p <0.05) among the 3 sub-groups regarding to the presence of MS: in the control sublot MS was found in 24% of women, in the 36% in the prediabetes group and in 44% of diabetes subgroup (fig. 3).

Table 1
DECADES OF AGE AND SEX DISTRIBUTION OF THE THREE GROUPS

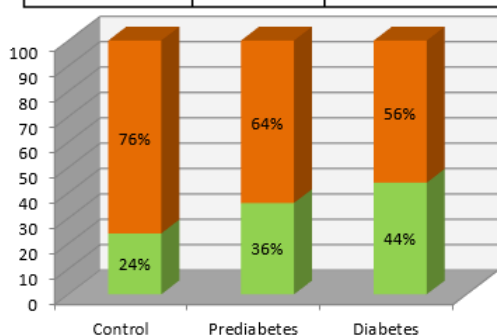| Decades	No. MEN	No. WOMEN
20 - 39 years	1 (2%)	1 (2%)
40 – 59 years	17 (34%)	17 (34%)
60 – 79 years	32 (64%)	32 (64%)
TOTAL	50 (100%)	50 (100%)

Fig. 3. Prevalence of metabolic syndrome in women in the subgroups

In men, in the control subgroup MS was found in 14% of men, in the prediabetes subgroup was 34%, while in the diabetic group MS was present in 38% of males, statistically significant difference (p <0, 05) (fig. 4).
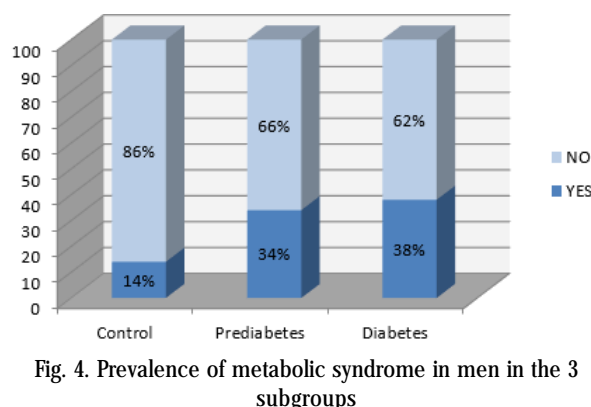

Fig. 4. Prevalence of metabolic syndrome in men in the 3 subgroups

Although women exhibited metabolic syndrome higher than men in all three subgroups, the differences were statistically insignificant (p = 0.701).

The prevalence of MS among the 300 patients analyzed was 32.3%.

By comparing visceral adiposity index (VAI) we obtained an average of 4.99 for prediabetic patients, the higher value, respectively 6.22 for patients with DM and the smallest average value of 4.85 being found in the control sublot, statistically significant difference between subgroups (p = 0.039) (table 2).

Regarding MS diagnosis, a positive linear correlation of the VAI value with the presence of MS was revealed in the control group, the median value of VAI in individuals with MS was 7.73 compared to the value of 2.78 registered in individuals without MS , statistically significant difference (p <0.001).

In the prediabetic group, the VAI value was positively correlated with the presence of MS, MS patients with an average VAI of 6.57 greater than the 3.26 of non-MS patients, statistically significant difference (p <0.001).

The same situation was also found in the diabetes group, the mean value in patients with MS with a value of 6.47, higher than the 1.69 value of non-MS patients, statistically significant difference (p <0.001).

In this case, in all subgroups, the increased VAI has been shown to be predictable for MS (fig. 5).

The metabolic syndrome had a prevalence of 32.3% in this study, close to the 25% estimated by IDF worldwide.

The metabolic syndrome has a particular impact on the individual and population level through the increasing frequency of its presence and the cardiovascular risk it causes. The increase in MS prevalence among the population is closely linked to the worrying rise in the prevalence of obesity, which has become epidemic around the world.

In 1997, World Health Organization data showed that the prevalence of overweight and obesity increased by 10-

Table 2
VAI EVALUATION IN THE 3 SUBGROUPS

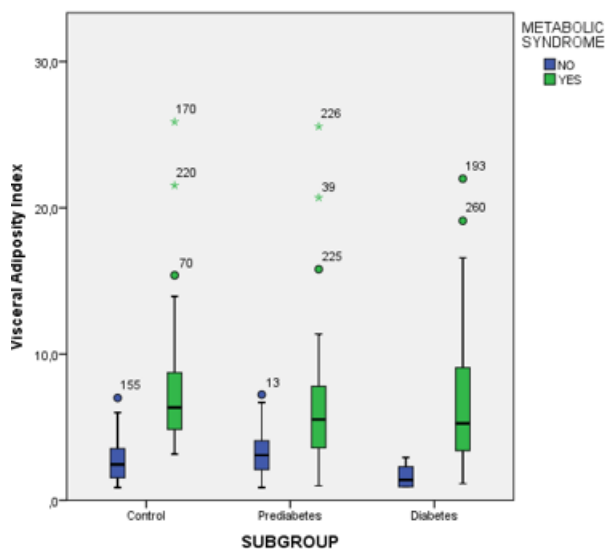| Variable	GROUP	Mean (SD)	95% CI	p
Visceral adiposity index (VAI)	SUBGROUP 1	4.99 (4.04)	4.182-5.805	0.039
	SUBGROUP 2	6.22 (4.19)	5.393-7,066	
	SUBGROUP 3	4.85 (4.13)	4.016-5.7	

Fig. 5. Correlation of VAI with the diagnosis of metabolic syndrome
in the 3 subgroups

40% over the past ten years. An estimated 302.1 million adults with obesity (8.2% of the world's population) are estimated globally, with a higher percentage in developed countries (20.4%) and in the developing countries (7.1 %).

In the developed countries, the high prevalence of obesity is generally correlated with low social, economic and educational status, while in the developing countries it is a result of lifestyle optimization, following urbanization and modernization. In the US, the proportion of overweight has increased by more than 30% since the 1980s, reaching 61% of the population overweight and 26% of obesity. It is thus explicable that about 1 adult in 4 (23%) has metabolic syndrome. It is thought that annual, overweight and obesity, are responsible for death in 300,000 cases, the costs associated with this pathology being $ 117 billion / year. With age, the prevalence of metabolic syndrome increases to 50%.

The current study shows a significant correlation of VAI values in both men and women with prediabetes and diabetes with MS.

Conclusions

Women showed higher metabolic syndrome than men in all 3 subgroups, but the differences were statistically insignificant (p = 0.701). MS prevalence among the 300 patients under study was 32.3%.

The diagnosis of MS was positively correlated with the VAI value in all 3 studied subgroups (p <0.001), thus proving that an increased VAI value is predictable for MS.

Our results demonstrated an association of VAI with MS in both men and women with prediabetes and diabetes,

these findings allow us to conclude that VAI is a simple, but effective indicator for estimating the presence of MS among adults.

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