ORIGINAL ARTICLE

Relationship between Waist Circumference and Metabolic Risk Factors in Argentine Women


ABSTRACT

Introduction: Metabolic syndrome (MetS) is a group of risk factors for cardiovascular disease. These factors include central obesity, usually assessed through waist circumference (WC).

Objective: To analyze the behavior of the different MetS variables (ATP III definition) in relation to changes in WC.

Subjects: We included 253 women who attended the Service of Endocrinology. We performed anthropometric, blood pressure, fasting glucose and lipid profile measurements. Patients were grouped into quintiles by WC: Q1 (56-80 cm), Q2 (80.1-89 cm), Q3 (89.1-96 cm), Q4 (96.1-103 cm) and Q5 (103.1-150 cm).

Results: There is a positive correlation between WC and BMI (p <0.0001, r = 0.87). In addition, there is a positive correlation between WC and triglyceride levels (p <0.0001, r: 0.28), glucose (p = 0.0001, r = 0.24), systolic blood pressure (BP) (p <0.0001, r = 0.27) and diastolic BP (p <0.0007, r: 0.21) and a negative correlation between WC and HDL levels (p <0.0001, r = -0.25).

Conclusions: As WC increases, cardiovascular risk factors (diastolic blood pressure, blood glucose, triglycerides, decreased HDL) increase. Rev Argent Endocrinol Metab 50:25-29, 2013

No financial conflicts of interest exist.

Key words: waist circumference in women, metabolic syndrome in women, metabolic factors

INTRODUCTION

Metabolic syndrome (MetS) is a group of risk factors for cardiovascular disease and type 2 diabetes mellitus (DM2) (1). There are many criteria for the diagnosis of MetS. Among the most widely used, is the definition set forth by the World Health Organization (WHO) in 1998, which focuses on the presence of insulin resistance (IR) as main component for the diagnosis of MetS, requiring also the presence of dyslipidemia, hypertension and/or microalbuminuria. In 2001, the National Cholesterol Education Program (NCEP; ATP III) provided a new definition of the MetS including waist circumference (WC), lipids, blood pressure and fasting glucose. In 2004, the International Diabetes Federation (IDF) emphasized central obesity as a necessary condition for the diagnosis of MetS (1).

Thus, the prevalence of MetS is dependent on the definition that is used, and it is higher (about 40%) when the IDF criteria are used. A decrease in WC measurement increases the prevalence of MetS but decreases mortality and the development of DM2. Therefore, waist circumference is likely to be a marker for the development of risk factors for MetS (1).

Likewise, central obesity per se is a risk factor for the development of cardiometabolic diseases.

The aim of our study is to analyze the behavior of the different MetS variables in relation to changes in WC in women. A secondary objective is to estimate the correlation between WC and the various components.
MATERIALS AND METHODS
The population included 328 women who presented at the Endocrinology Service at Hospital Churruca from January to December 2009 for various reasons. All patients were questioned about family and personal history, habits and examined by an endocrinologist.

In order to avoid confounders, we excluded patients with a diagnosis of diabetes mellitus (DM2), hypothyroidism (TSH > 5), hyperthyroidism (TSH < 0.01), hyperandrogenism, chronic disease and all those under treatment with hypoglycemic drugs, glucocorticoids, lipid-lowering agents and hormone therapy.

In all patients, blood pressure, waist circumference, height and weight were measured, and the body mass index (kg/m²) was calculated. Blood pressure was measured after a 10-minute rest with a standard mercury sphygmomanometer.

Waist circumference was defined as the minimum circumference between the lower end of the rib cage and the iliac crest. Patients were grouped by quintiles according to waist circumference: Q1 (waist between 56 and 80 cm), Q2 (waist between 80.1 and 89 cm), Q3 (waist between 89.1 and 96 cm), Q4 (waist between 96.1 and 103 cm) and Q5 (waist between 103.1 and 150 cm.).

Blood samples were drawn from all patients for biochemical testing at 8 to 9 AM after a fasting period of 12 hours.

Measurements performed included: blood glucose, total cholesterol, HDL-cholesterol (HDL), LDL-cholesterol (LDL), triglycerides (TG), plasma creatinine, liver function tests, uric acid and TSH. TSH was measured by chemiluminescence 3rd generation Access assay. All other measurements were performed using colorimetric enzymatic methods.

The definition of metabolic syndrome proposed by the National Cholesterol Education Program Adult Treatment Panel III (ATP III) was used. The panel defined metabolic syndrome as the presence of three or more of the following risk factors: (1) waist circumference ≥ 88 cm in women); (2) fasting triglycerides ≥150 mg/dl; (3) HDL cholesterol <50 mg/dl in women; (4) systolic or diastolic blood pressure ≥130/85 mmHg; and (5) fasting glucose ≥110 mg/dl.

This study was approved by our institutional ethics committee and all patients signed an informed consent.

Statistical analysis: results are expressed as mean ± standard deviation (SD). Non-parametric variables were evaluated by χ². Parametric variables were evaluated by ANOVA followed by the Bonferroni test. Correlations between variables were calculated using the Spearman test. Significant differences were considered at p < 0.05.

RESULTS
Out of 328 women screened for the study, 253 were included. There were no differences in the number of patients in each quintile. The mean age was 47.89±15.15 years (range between 16 and 88 years). We found a significant difference in age in patients in Q3 and Q4, who were older than patients in all other quintiles.

When analyzing family and personal history and habits, no significant differences were found among quintiles.

Table 1 shows the various components of the metabolic syndrome divided according to waist circumference (WC), where we can see a significant increase in WC as quintiles increase, a behavior that is also observed when weight and body mass index (BMI) are analyzed.
When systolic blood pressure values were evaluated, even if there was an increase similar to that observed with BMI and weight, such increase was significant as from Q3. As regards diastolic blood pressure, significant differences were observed only in Q5. Blood glucose levels were significantly higher in Q2, Q4 and Q5. The increase in TG levels was significant only in Q5. Finally, a significant decrease in HDL-c was found in Q4 and Q5.

When the components of the metabolic syndrome (Table No. 2) were analyzed, we observed an increase in the number of such components as quintiles increased. Furthermore, a significant difference was found in the number of patients with metabolic syndrome as from quintile 3.

We found a positive correlation between WC and BMI values (p < 0.0001, r: 0.87). In addition, a positive correlation was found between WC and triglycerides (p < 0.0001, r: 0.28), blood glucose (p = 0.0001, r: 0.24), systolic blood pressure (BP) (p < 0.0001, r: 0.27) and diastolic BP (p < 0.0007, r: 0.21), and a negative correlation between WC and HDL (p < 0.0001, r: -0.25) (not plotted).

### TABLE 1. Anthropometric and biochemical parameters distributed by quintiles

<table>
<thead>
<tr>
<th></th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
</tr>
</thead>
<tbody>
<tr>
<td>N = 253</td>
<td>54</td>
<td>49</td>
<td>57</td>
<td>42</td>
<td>51</td>
</tr>
<tr>
<td>Age (years)</td>
<td>40.85 ± 15.84</td>
<td>47.85 ± 12.40</td>
<td>51.28 ± 13.67*</td>
<td>51.71 ± 16.49*</td>
<td>48.51 ± 15.20</td>
</tr>
<tr>
<td>Waist (cm)</td>
<td>74.33 ± 5.04</td>
<td>85.22 ± 2.30*</td>
<td>92.54 ± 2.34*</td>
<td>99.21 ± 2.09*</td>
<td>115.02 ± 10.12*</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>55.73 ± 7.25</td>
<td>64.08 ± 8.99*</td>
<td>68.10 ± 7.77*</td>
<td>75.88 ± 8.75*</td>
<td>93.24 ± 15.29*</td>
</tr>
<tr>
<td>Height (m)</td>
<td>1.60 ± 0.05</td>
<td>1.59 ± 0.05</td>
<td>1.58 ± 0.06</td>
<td>1.58 ± 0.07</td>
<td>1.59 ± 0.07</td>
</tr>
<tr>
<td>BMI (kg/m2)</td>
<td>21.90 ± 2.73</td>
<td>25.41 ± 3.62*</td>
<td>27.31 ± 3.14*</td>
<td>30.53 ± 3.50*</td>
<td>37.11 ± 5.86*</td>
</tr>
<tr>
<td>Systolic BP (mmHg)</td>
<td>114.81 ± 15.14</td>
<td>120.31 ± 17.21</td>
<td>124.82 ± 17.79*</td>
<td>126.90 ± 16.42*</td>
<td>130.37 ± 17.03*</td>
</tr>
<tr>
<td>Diastolic BP (mmHg)</td>
<td>71.02 ± 10.61</td>
<td>71.98 ± 10.14</td>
<td>75.71 ± 12.34</td>
<td>75.36 ± 10.84</td>
<td>78.92 ± 11.63*</td>
</tr>
<tr>
<td>Blood glucose (g/dL)</td>
<td>0.92 ± 0.09</td>
<td>1 ± 0.16*</td>
<td>0.98 ± 0.11</td>
<td>1.01 ± 0.14*</td>
<td>1.03 ± 0.14*</td>
</tr>
<tr>
<td>HDL (mg/dL)</td>
<td>58.85 ± 12.61</td>
<td>53.78 ± 10.75</td>
<td>55.63 ± 12.91</td>
<td>51.19 ± 13.53*</td>
<td>49.80 ± 14.03*</td>
</tr>
<tr>
<td>TG (mg/dL)</td>
<td>79.02 ± 55.25</td>
<td>85.86 ± 37.01</td>
<td>108.40 ± 80.65</td>
<td>110.69 ± 53.77</td>
<td>126.43 ± 59.08*</td>
</tr>
</tbody>
</table>

BMI: body mass index. BP: blood pressure. TG: triglycerides
Quintiles: (Q.) * p<0.01. Q2, Q3, Q4, Q5 vs. Q1.

### TABLE 2. Distribution of MetS components in number of patients according to quintiles (Q)

<table>
<thead>
<tr>
<th>Components</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
<th>Q5</th>
</tr>
</thead>
<tbody>
<tr>
<td>0*</td>
<td>28</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1*</td>
<td>19</td>
<td>20</td>
<td>11</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>2*</td>
<td>6</td>
<td>11</td>
<td>22</td>
<td>7</td>
<td>12</td>
</tr>
<tr>
<td>3*</td>
<td>0</td>
<td>5</td>
<td>16</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>4*</td>
<td>1</td>
<td>3</td>
<td>7</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>5#</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
</tbody>
</table>

* p < 0.01. #p<0.05. Q2, Q3, Q4, Q5 vs. Q1.
DISCUSSION

A large number of studies have demonstrated a correlation between WC (visceral fat) and components of the metabolic syndrome, and is assumed to be a causal factor by releasing free fatty acids into the portal system (2-4). This would lead to an inhibition of glucose uptake and oxidation by muscle and other organs, which might explain the increase in insulin secretion. If this situation persists chronically, it might lead to pancreatic beta cells dysfunction, promoting diabetes mellitus type 2 (4).

Furthermore, basic and clinical trials have revealed the pathogenic role of ectopic fat storage, mainly in abdominal/visceral location. Visceral adipocytes are assumed to be more sensitive to lipolytic stimuli and less sensitive to antilipolytic stimuli (5, 6). The excessive flow of free fatty acids lead to cell accumulation in various organs, mainly in the liver, muscle and pancreas (lipotoxicity) favoring insulin resistance and impaired function of pancreatic beta cells (7).

Thus, excess free fatty acids serves as a substrate for production of triglycerides and triglycerides-enriched lipoproteins by the liver and the increased clearance of these substances contributes to depletion of circulating HDL (8).

Recent observations have emphasized that visceral adipocytes have an attenuated secretion of adiponectin, which would favor impairment in peripheral insulin sensitivity, in glucose homeostasis and triglycerides (9, 10).

Snijder et al (4) found an association between WC and the risk for diabetes, hypertension and dyslipidemia in a population of 11,000 subjects of both genders. Unlike our findings, they did not find a significant association between anthropometric parameters and blood pressure, after adjustment for BMI. Authors hypothesize that obesity per se would be more important than fat distribution in the physiopathogenesis of hypertension, in agreement with other studies conducted in Swedish women, where authors (11) found a more significant correlation between BMI and systolic and diastolic blood pressure than with WC.

The role of insulin resistance in the regulation of blood pressure is still a matter of debate, as recent studies have shown a modest association between higher insulin sensitivity and lower risk of hypertension (12). Environmental factors such as alcohol, sedentary lifestyle and sodium intake appear to be other important determinant factors in hypertension (13).

In addition, we found an excellent correlation between BMI and WC ($p = 0.0001, r = 0.87$). We also found a significant positive correlation between WC and blood glucose, triglycerides and a significant negative correlation between WC and HDL.

Obesity is an important cardiovascular risk factor included together with diabetes, hypertension, dyslipidemia and coronary artery disease shown by different epidemiological studies. Furthermore, fat distribution is also an important factor; excess visceral or central fat is associated with an increased risk of cardiovascular disease (14).

Waist circumference is an estimate of abdominal adiposity, which consists of subcutaneous abdominal adipose tissue and intra-abdominal adipose tissue. The easiest, more rapid and economical method for measuring waist circumference is the measuring tape. Both computed tomography and magnetic resonance imaging are considered the gold standard methods for determining the quantity and quality of adiposity (14).

Thus, BMI provides information about volume and body mass, while WC provides information on fat distribution. In general, BMI and WC have a high correlation as it has been shown in our study and by other authors (15-18).

As regards the relationship between BMI and WC we found that for a woman with normal weight ($BMI < 25 \text{ kg/m}^2$), with overweight ($BMI 25.0$ to $29.9 \text{ kg/m}^2$), with obesity
I (BMI 30.0-34.9 kg/m²), and obesity II/III (BMI > 35 kg/m²), the approximate waist circumference was 74 cm; 85-92 cm; 99 cm and 115 cm, respectively, slightly lower than that found by Ardem et al when analyzing data from NANHES III and the Canadian Heart Health Surveys (19).

This is a cross-sectional study and therefore it is not possible to evaluate a temporal relationship between metabolic syndrome and cardiovascular disease.

Another limitation to this study is that only women were evaluated, and data cannot be extrapolated to the male gender.

These findings suggest that fat distribution and the prevalence of metabolic syndrome in Argentine women (37%) slightly differ from data obtained in American women (1, 19). We have also shown that both BMI and waist circumference are useful to suspect metabolic risk. Therefore, we consider that female patients with a BMI ≥ 25 (overweight) should be considered at risk and be evaluated for the presence of metabolic syndrome in order to prevent and/or treat cardiometabolic risk factors. We also consider that measurement of WC is a simple, practical and easy method that will allow us to identify in daily practice the group of patients at risk for developing MetS and the consequent increase in the risk of developing cardiovascular disease and type 2 diabetes.

REFERENCES


11. Kristjansson K, Sigurdsson JA, Lissner L, Sundh


