

# Biochemical Markers Present in a Population Susceptible to Suffering From Metabolic Syndrome

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## Abstract

**Objective:** To determine the prevalence of metabolic syndrome (SM) according to Adult Treatment Panel III ATP III and its relation with uric acid concentration and C-reactive protein, in people aged from 45 to 60 years old from the Getsemaní neighborhood of Cartagena city, Colombia.

**Materials and Methods:** Type of study: Observational, Descriptive-Correlation. Population of 802 inhabitants from the Getsemaní neighborhood of Cartagena city. We analyzed 302 inhabitants from a random sample with 95% confidence level and 5% of error level. The ATP III diagnostic criteria were applied, the applied instrument had basic data about the general context (social, demographic, economic aspects, family history, work activity and its physical characteristics: weight, waist circumference, blood pressure, calculation of BMI), as well diagnostic tests as: glycaemia, total cholesterol, triglycerides, HDLc, LDLc, uric acid, ultrasensitive C-reactive protein.

**Results:** The population susceptible to metabolic syndrome presented a prevalence of 18%. The most prevalent metabolic syndrome factor was abdominal obesity with 85%, followed by an increase in triglycerides by 76%.

**Conclusion:** When applying the ATP III criteria, the prevalence of metabolic syndrome was considered high. There was no significant association of C-reactive protein values with the possibility of developing metabolic syndrome in both men and women, but uric acid results were found to be correlated in the group of women susceptible to MS with a  $p = 0.0022$ .

**Keywords:** hypertension, uric acid, obesity, risk factors

## 1. Introduction

The Metabolic Syndrome (MS) represents a problem for people's health. It not only occurs in adults, but also affects young people (Heiss et al., 2014; Biben, Orkin, & Bopp, 2016) and is associated with other diseases such as depression (Virtanen et al., 2017). The most important cause of SM is the poor management of lifestyle due to unbalanced diet, sedentary lifestyle and family history of chronic diseases (Rodríguez & García, 2016; Rosales, Rivas, & Troconis, 2017; Bell Castillo et al., 2017).

SM is a pathological condition associated with insulin resistance and hyperinsulinemia that presents a high risk of developing type 2 diabetes mellitus and atherosclerotic cardiovascular disease (Carvajal, 2017). This makes it a subject of debate in the medical community because it is related to diseases that cause higher mortality rates worldwide (Cabalé Vilariño, Sánchez Serrano, Gutiérrez Carbonell, & Flores Sánchez, 2011). Its prevalence varies according to factors such as gender, age, ethnicity; it is between 15% and 40%, being higher in the population of Hispanic origin (Cabalé Vilariño et al., 2011; Heiss et al., 2014; Aguilar, Bhuket, Torres, Liu, & Wong, 2015). In 2001 the National Cholesterol Education Program (NCEP) in the Adult Treatment Panel III (ATP III) determined that three or more of the following diagnostic criteria must be met in order to diagnose MS: high abdominal circumference (>102 cm in men and >88 cm in women), triglycerides  $\geq 150$  mg/dl, low HDL (men <40 mg/dl and women HDL <50 mg/dl), high blood pressure  $\geq 130/85$  mm Hg, glycaemia >110 mg/dl including Diabetes Mellitus (Castro & Yaqueline, 2016; Giraldo, Perdomo, Aristizábal, & Restrepo, 2017; Iliff, 2001).

In 2004, with the update of the American Diabetes Association, fasting glycemia was modified to 100 mg / dl for diabetes (Kahn, 2003), likewise; thrombogenesis, inflammation, uric acid, stress, smoking, and sedentary lifestyle are considered other factors for undergoing this syndrome (Carvajal, 2017; Pineda, 2008). In 2012, the American Diabetes Association (ADA) and the European Association for the Study of Diabetes (EASD) published a consensus statement on the management of hyperglycemia in patients with type 2 diabetes (DM2) (Díaz, 2015). The association of hyperuricemia and systemic arterial hypertension has long been recognized as one of the biomarkers for early detection (Srikanthan, Feyh, Visweshwar, Shapiro, & Sodhi, 2016). This is based on the following observations (Jossa et al., 1994): the prevalence of hyperuricemia is approximately 20 to 40% in untreated hypertensive people and approximately 50 to 70% of patients with renal insufficiency and hypertension; gout prevails between 2 and 12% of patients with hypertension, increasing the prevalence of hyperuricemia with the increase in blood pressure in the general population (Borghetti et al., 2015; Culleton, Larson, Kannel, & Levy, 1999; Melnyk, 2017).

Due to the difficulty in distinguishing the cause and the pathological basis of the relationship between hyperuricemia and hypertension, it has been found that renal depuration of uric acid depends on tubular secretion and post-secretory reabsorption, which has been reported to be impaired in patients with arterial hypertension (Kang & Nakagawa, 2005). Within the ARIC study (Ballantyne et al., 2005; Garg et al., 2017), factors that predispose to hyperinsulinemia were taken, and it was found that hyperuricemia ( $> 6.4$  mg/dl) was positively associated with hyperinsulinemia and MS, since it is a demonstrable factor that indicates a high probability of developing these two medical conditions. In MS pathophysiology, metabolism alterations are implicated, such as the glycolipid profile, among other pro-inflammatory and prothrombotic markers. (Esser, Legrand-Poels, Piette, Scheen, & Paquot, 2014; Testa et al., 2015); which helped to determine the increase in prevalence significantly related to the increase in uric acid concentrations (Jiménez et al., 2009; Valenzuela, 2016). Other studies demonstrate the association between MS and / or Insulin resistance with the increase of ultrasensitive C-reactive protein (hsCRP), a well-known marker of inflammation (Fernández, 2016; Han et al., 2002; Sakkinen, Wahl, Cushman, Lewis, & Tracy, 2000).

Therefore, the objective was to determine the prevalence of metabolic syndrome according to ATP III and its relationship with the concentration of uric acid and ultrasensitive C-reactive protein in people aged from 45 to 60 years in the Getsemani neighborhood of Cartagena city, Colombia.

## 2. Materials and Methods

Descriptive study with a correlation component, the target population was 802 inhabitants of the Getsemani neighborhood of the city of Cartagena de Indias between the ages of 45 and 60 years. The sample was of 302 inhabitants randomly selected, with a 95% confidence level and an error level of 0.05%. Participants were previously informed and signed informed consent. The study was approved by the research committee. An instrument was applied prior internal validation with a Cronbach's alpha coefficient of 0.75. The questions included basic data such as sociodemographic, economic, family history, work activity, among others. Clinical data were taken, such as: weight, waist circumference, blood pressure measurement, sedentary lifestyle, calculation of the body mass index (BMI). Blood pressure was determined by the average of two measurements using the participant's right arm, taken 5 minutes apart with the participant seated (National Joint Committee VII). The height was measured with a stadiometer and the weight with a conventional balance, without footwear. The waist perimeter was measured with a measuring tape. The sedentary lifestyle was defined as the lack of physical activity in free time, in the last month, during 2 hours and a half per week, in sessions of at least 30 minutes. The practices investigated were: walking, jogging, cycling, playing soccer, volleyball, dancing. Blood samples were taken after fasting 8-12 hours to determine levels of glycaemia, total cholesterol, triglycerides, HDLc, LDLc, uric acid, ultrasensitive C-reactive protein, calculation of LDLc by the Friedewald formula. Subsequently, they were centrifuged at 2500 rpm for 15 minutes, refrigerating until they were measured. All determinations were made with a Mindray BS-200 equipment, with normal and high-level control sera from HUMAN, complying with all the quality controls. Endpoint tests were used, for quantification (hsCRP) the method used was turbidimetric. For the diagnosis of metabolic syndrome, the NCEP / ATP III criteria were applied (Expert Panel on Detection, 2001). For glycaemia, the update of the American Diabetes Association 2004 was used, where the fasting glycaemia was modified to 100 mg/dl (Association, 2014; Iliff, 2001).

The processing of the information and data statistical analysis were performed using Excel 2007. The descriptive statistical analysis of the data was expressed as prevalences, mean, mode and standard deviation. Correlation analyzes were performed by calculating the Pearson (r) calculation with a 95% of significance and a p-value of  $\leq 0.05$ , for which the SPSS 19.0 ® for Windows was utilized.

### 3. Results

Of 302 people between 45 and 60 years old 125 (41%) were male and 177 (59%) female. The average age was 51 years (SD 4.8), average weight 72.9 (SD 14.7), the average waist circumference of 88.9 (SD 11.7), and a BMI of 35.1 Kg/m<sup>2</sup> (SD 14.5) related to obesity. In relation to the mean arterial pressure was 88 mmHg (SD 7.4). The most frequent work activity was commerce with 67 (22%) and household activities with 97 (32%). In turn, when questioned about sedentary lifestyle, it was found that 193 (64%) of the people stated that they performed some of the practices investigated, and 109 (36%) people do not perform them, being able to consider them as sedentary.

A prevalence of metabolic syndrome of 54 (18%) was found in this group of people who presented more than three risk factors, according to the criteria of ATP III, while 248 (72%) people had less than three risk factors, where according to Adult Treatment Panel III (ATPIII) it allows to diagnose a patient with the presence of three or more alterations in the same individual. The prevalence of metabolic syndrome was higher in women 39 (72%), than in men 15 (28%). The most relevant risk factor was the abdominal perimeter in 46 (85%), followed by the HDL concentration in 43 (79.6%) and third the concentration of decreased triglycerides in 41 (75.9%). (Table 1)

Table 1. Susceptibility and prevalence of suffering from metabolic syndrome (MS) on the total population and by sex according ATP III criteria

Risks factors according ATP III criteria	n (%)	Susceptible or not of suffering from MS - ATP III	n (%)	SM prevalence according ATP III	n (%)
Abdominal perimeter	46 (85,10)	Yes	54 (18)	Men	15 (28)
Triglycerides >150	41 (75,90)	No	248 (82)	Women	39 (72)
HDL	43 (79,60)	Total	302 (100)	Total	54 (100)
High blood pressure	10 (18,50)				
Glycaemia	12 (22,20)				
Total	152 (50,33)				

n: Frequency. (%): Percentage.

The comparison of the anthropometric measurements between men and women with metabolic syndrome did not show a significant difference. The variables of the biochemical tests in both sexes show that there is marked difference in glycaemia, the average value in men was 121.6 mg/dl and in women of 90.4 mg/dl; In relation to triglycerides, a mean of 228.1 mg/dl was found in men and 170.6 mg/dl in women. According to the results of the ultra-sensitive C reactive protein, the average in men was 9.6 mg/l, and in women 5.7 mg/l, increased in both sexes as a possible predictor of an inflammatory event. (Table 2)

Table 2. Results of the biochemical tests of the susceptible and prevalent population of suffering metabolic syndrome according to the ATP III criteria

	Male n (%)			Female n (%)		
	Mean	Sd	CI 95% (LL-UP)	Mean	Sd	CI 95% ((LL-UP)
Glucose (mg/dl)	121,667	84,5701	(74,8332 - 168,5)	90,4872	35,4637	(78,9911 - 101,983)
Triglycerides (mg/dl)	228,133	51,1425	(199,812 - 256,455)	170,667	55,6159	(152,638 - 188,695)
Cholesterol (mg/dl)	230,067	117,209	(165,158 - 294,975)	183,308	50,4356	(166,958 - 199,657)
HDL (mg/dl)	39,84	9,29353	(34,6934 - 44,9866)	41,8872	8,86309	(39,0141 - 44,7603)
LDL (mg/dl)	122,733	36,5444	(102,496 - 142,971)	111,026	35,4828	(99,5234 - 122,528)
Uric acid (mg/dl)	5,66933	1,21366	(4,99723 - 6,34144)	4,72231	1,31608	(4,29568 - 5,14893)
Ultra sensitive C reactive protein (mg/dl)	9,68667	28,6353	(6,1710 - 25,5444)	5,75641	6,09775	(3,77975 - 7,73308)
Total	15 (28)	54 (100)		39 (72)		

n: Frequency. (%): Percentage. Sd: Standard deviation. LL: Lower limit. UL: Upper limit.

Regarding the correlation of C-reactive protein and uric acid in women susceptible of suffering metabolic syndrome showed that there is no correlation between these and the other biochemical markers such as glycaemia and lipid profile. However, uric acid levels correlate moderately with C-reactive protein levels ( $r = 0.4756$ ,  $p = 0.0022$ ). In men, levels of C-reactive protein and uric acid do not correlate with biochemical markers. (Table 3)

Table 3. Comparison of the correlational analysis of biochemical markers in women and men

Biochemical Markers	Glucose (mg/dl) <sup>♂</sup>	Total Cholesterol (mg/ dl) <sup>♀</sup>	Total Cholesterol (mg/ dl) <sup>♂</sup>	HDL (mg/dl) <sup>♀</sup>	LDL (mg/dl) <sup>♂</sup>	Uric acid (mg/dl) <sup>♀</sup>
Glucosa (mg/dl)		0,11	0,76**	0,05	0,63*	0,02
Total Cholesterol (mg/ dl)	0,76**			0,4*	0,67**	0,001
LDL (mg/dl)	0,62*	0,65**	0,66**	0,5**		-0,08
Ultra sensitive C reactive protein (mg/dl)	0,00	0,00	-0,05	0,03	0,03	0,48**

\* $p \leq 0.01$ ; \*\* $p \leq 0.001$ ; (<sup>♂</sup>)Male (n=15); (<sup>♀</sup>)Female (n=39).

As for the anthropometric measurements in women, a weak positive correlation was found between uric acid and weight ( $r = 0.32117$ ,  $p = 0.045$ ). With the rest of the anthropometric variables, there is no significant correlation between uric acid and C-reactive protein (Table 4). The results did not have statistical significance in the correlation between uric acid and C-reactive protein and the other anthropometric variables in men susceptible to suffering metabolic syndrome. (Table 4)

Tabla 4. Comparison of the correlational analysis of biochemical markers and anthropometric measurements in women and men

ANTHROPOMETRIC VARIABLES	Weight (Kg) <sup>♀</sup>	Weight (Kg) <sup>♂</sup>	BMI (Kg/m2) <sup>♀</sup>	BMI (Kg/m2) <sup>♂</sup>	Systolic blood pressure (mmHg) <sup>♀</sup>	Diastolic blood pressure (mmHg) <sup>♀</sup>	Diastolic blood pressure (mmHg) <sup>♂</sup>	Uric acid (mg/dl) <sup>♀</sup>
Weight (Kg)			0,89**	0,73**				0,32***
Waist circumference (cm)	0,74**	0,89**	0,71**	0,81**	0,37**	0,33***	0,5***	
Systolic blood pressure (MmHg)							0,69**	
Uric acid (mg/dl)		0,5***						
Ultra sensitive C reactive protein (mg/dl)								0,48**

\*  $p \leq 0.01$ ; \*\*  $p \leq 0.001$ ; \*\*\*  $p \leq 0.05$ ; (<sup>♂</sup>) Male (n=15); (<sup>♀</sup>)Female (n=39).

#### 4. Discussion

This study is one of the first reports on the prevalence of metabolic syndrome and its correlation with ultrasensitive C-reactive protein and uric acid in Cartagena city. The obtained analyzes are congruent on which the general population presented a high obesity index, attributing this basically to a sedentary lifestyle (Rodríguez & García, 2016). Several studies report that the intake of high-calorie diets and saturated fats, but low in fiber, has become in recent years a constant practice in developing countries; together with the sedentary lifestyle resulting from the urbanization process, they have created the conditions for the increase of the frequency of obesity, especially abdominal, which are modifiable factors, typical of the individual (López-Jaramillo, Pradilla, Castillo, & Lahera, 2007; Márquez-Sandoval, Bulló, Vizmanos, Casas-Agustench, & Salas-Salvadó, 2008; Soca, 2009; Matía Martín, Lecumberri Pascual, & Calle Pascual, 2007). It is acknowledge that there are no organized programs to prevent these risk factors and promote healthy habits.

The prevalence of Metabolic Syndrome found in the study was 18%, a value that agrees with the prevalence found in studies done by Manzur F., which was 22%, in a population of the municipality of Arjona, using in this study the ATP III AHA criteria (Manzur, de la Ossa, Trespalacios, Abuabara, & Lujan, 2008), along with Lizarazu I, who reported a prevalence of 23% on a group of people between 40 and 60 years, the average age of workers in her study participants was 51.3 years (Lizarazu Díazgranados, Rossi Trespalacios, Iglesias Acosta, & Mendoza Torres, 2010). In the study conducted by Manzur, the socioeconomic level agrees with the one used in the present study as well as the age being that 84% were under 58 years of age (Manzur et al., 2008).

Regarding sex, the prevalence found was higher in women with 72%. These data are similar to those reported by the Navarro E study, in which 78.7% prevalence was in women (Mody, Joshi, Khera, Ayers, & Rohatgi, 2016; Ridker, Rifai, Rose, Buring, & Cook, 2002). This may be due to the fact that the majority of the working population is male and the survey was carried out during working hours, which does not affect the reliability of the results; in previous studies no significant difference in prevalence between men and women has been demonstrated. It differs with the results found by Lizarazu I, where the prevalence of metabolic syndrome was higher in men than in women (Lizarazu Díazgranados et al., 2010).

The most prevalent component of the metabolic syndrome in the study was abdominal obesity within the metabolic syndrome group with 85%, being similar to those reported by Manzur F, where abdominal obesity predominated in 70.27% in men and in 69.23% in women (Manzur et al., 2008). On the other hand Lizarazu, found that 93% of the respondents presented abdominal obesity (Lizarazu Díazgranados et al., 2010). It should be noted that the waist circumference used was not adjusted with our ethnic group, even though it was the most relevant component of the metabolic syndrome, which could be even greater when applying the new criteria, including the abdominal perimeter adapted to our ethnic group. Although in the study this prevalence is maintained, an increase could be observed when the cut-off point that defines abdominal obesity decreases, thus improving sensitivity, but worsening the specificity, by diagnosing people who eventually do not have metabolic syndrome. However, it was found that hyperglycemia is higher in men due to not complying with any type of diet or physical exercise regime which leads to an increase in body index, where it is common to find these elements increased in women over 55 especially with menopause with polycystic ovarian syndrome (Tovar & Celemin, 2016; Pulido et al., 2016; 2011).

The plasma levels of ultrasensitive C-reactive protein were found significantly higher in susceptible people than in those who are not, confirming the relationship of this parameter with the metabolic syndrome; However, statistically no strong correlation was found in either men or women with ultrasensitive C-reactive protein, glucose values, lipids and anthropometric measurements, in susceptible persons for metabolic syndrome, deferring this with the results obtained by Ridker and Matesanz, who found weak significant relationship with the data of C-reactive protein and lipid profile (Matesanz Ruiz et al., 2006; Ridker, Buring, Cook, & Rifai, 2003; Ridker et al., 2002).

In general, the correlation found between ultrasensitive C-reactive protein and lipid levels in men and women has been weak, but without statistical significance. Although, it is necessary to highlight the usefulness of C-reactive protein as a strong predictor of cardiovascular risk, also the technique for its determination is affordable and can be performed easily.

Regarding the correlation analysis, none of the results showed statistical significance between uric acid in people susceptible to metabolic syndrome, except for women, differing from the study conducted by Jiménez which show that the prevalence of metabolic syndrome increases significantly with the increase in uric acid concentrations. Even so, it remains undetermined the lower excretion of uric acid in patients with metabolic syndrome and its association with systemic diseases (Fernández, 2016; Jiménez et al., 2009; Tovar & Celemin, 2016).

## 5. Conclusion

When applying the ATP III criteria, the prevalence of metabolic syndrome is high and very similar to that found in other studies in Colombia, becoming a basis for further studies. It should be noted that despite the increase in the abdominal perimeter, these patients had a lower mean blood pressure than that established by the ATP III for metabolic syndrome, it could be said that the cardiovascular risk can start from values lower than those required by this criterion. Although a significant relationship was not found between uric acid and ultrasensitive C-reactive protein with the variables studied, it continues to be documented about the coexistence of these two factors with the Metabolic Syndrome.

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## Competing Interests Statement

The authors declare that there are no competing or potential conflicts of interest.

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