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Status in Lipid Parameters in Leptin and Resistin in a Group of Obese Men Developing a Metabolic Syndrome

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ABSTRACT

Introduction: Our work is a comparative study that aims to evaluate serum levels of leptin, resistin, insulin and detects possible correlations that may exist between these parameters in a population of obese diabetic males with metabolic syndrome. Material and methods: This was a case-control study in which we recruited 44 obese diabetic men with metabolic syndrome from the National Institute of Nutrition of Tunisia and 35 control men. Studied parameters were measured for both groups and the data were analyzed by statistical methods. Results: Our results revealed significant differences in leptin and resistin levels between the two groups. In obese diabetic subjects, leptinemia was 17.90 ng/ml against 5.58ng/ml for the controls. The resistinemia was 9.85ng/ml. In obese against 2.33 ng/ml for the controls. The correlation study showed a significant positive correlation between resistin and BMI (r=0.659; p<0.0001) between resistin and waist circumference (r=0.575; p<0.0001) Resistin and blood glucose levels (r=0.44; p<0.0001) between resistin and systolic and diastolic blood pressure respectively (r=0.38, p<0.011) and (r=0.37; p<0.014). Between resistin and triglyceride (r=0.545, p<10-4). Conclusion: This study helped to better understand the role of leptin and resistin in obese subjects with metabolic syndrome and allowed to demonstrate significant correlations between the studied parameters

Keywords: Obesity, Metabolic syndrome, Leptin, Resistin, Lipids

A LIST OF ABBREVIATIONS

MS: Metabolic Syndrome
WHO: World Health Organization
NCEP-ATP III: The National Cholesterol Education Program Adult Treatment Panel
IDF: International Diabetes Federation
BMI: Body Mass Index
WC: Waist Circumference
SBP: Systolic Blood Pressure
DBP: Diastolic Blood Pressure
TC: Total Cholesterol
TG: Triglycerides
HDL-C: HDL-Cholesterol
Gly: Glycaemia
Homa-IR: Homeostasis model assessment of insulin resistance
OR: Odds Ratio
VLDL: Very Low-Density Lipoprotein
RR: Relative risk
LDL: Low-Density Lipoprotein

INTRODUCTION

The metabolic syndrome (MS), previously called syndrome X, syndrome of REAVEN, insulin resistance syndrome (IR), the deadly quartet. It is not a disease in itself, rather, it refers to a cluster of physiological signs which increases the risk of type 2 diabetes, heart disease and cerebral vascular disease (stroke) (1). These warning signs of serious or chronic health problems are not always visible or felt by the affected person. However, tests prescribed by the physician during medical examination reveal them.

MS has become a growing global public health problem, responsible for a global epidemic. Its prevalence changes according to the geographical area, ethnicity, culture, gender, the level of development country or social class and age. It is associated with many comorbidities, such as hypertension, dyslipidemia, sleep apnea... Therefore, finding strategies to prevent and combat this scourge is becoming increasingly urgent in order to preserve good health and good lifestyle and thus reduce the incidence of these complications.

Genetic factors may be the source of this syndrome, but also lifestyle plays a major role in its occurrences, such as the lack of physical activity, food pace, overconsumption of sugars, lipids and alcohol are important elements in the weight gain and visceral obesity (2). The MS was discovered the first time in 1923 by Kylin who was a Swedish doctor, and it was updated in 1956 by John Wave who linked the MS with visceral obesity and with atherosclerosis (3).

In recent years, several criteria have been proposed for diagnosing MS, from where came the different definitions of different organizations such as the World Health Organization (WHO), the National Cholesterol Education Program Adult Treatment Panel (NCEP-ATP III), International Diabetes Federation (IDF).

In the present work, we presented the practical study we have conducted with our patients by analyzing the results of the anthropometric, biochemical and hormonal parameters, then we compared them with similar studies. We gave a particular importance to resistin considering the place it occupies in the onset of metabolic syndrome complications; such as cardiovascular diseases and type 2 diabetes.

MATERIALS AND METHODS

This is a case-control study in which we compared the results of lipid profile, blood sugar levels, resistinemia, insulinaemia and leptinemia found in a group of obese men developing a metabolic syndrome compared to a control group. Then we proposed to look for possible correlations between these different parameters.

Study population

Our case-control study involved 44 diabetic obese men with metabolic syndrome and 35 control men. Diabetic obese men were recruited from the "C" unit of nutritional and therapeutic diet of the National Institute of Nutrition and Food Technology of Tunisia. A man was considered obese when his body mass index (BMI), which is equal to the weight divided by the height squared, is greater than 30 kg/m². The men selected for the survey were previously informed of the objectives of the work and showed no pathology or metabolic complications other than obesity and diabetes.

As for the men in the control group, they were recruited from the patient's companion of in the "C" department who accepted to participate in the survey by receiving as a reward the results of the classical biological assessment (blood glucose levels, HDL-Cholesterol, total cholesterol, Triglycerides). The men of both groups gave their prior informed consent to participate in our investigation. We considered in our survey the definition of metabolic syndrome as recommended by the IDF.

Methods and tools for collecting data

For the collection of data, we used:

A questionnaire
This instrument of measurement allowed us to collect information on general characteristics of the survey such as age, education, occupation… (Appendix I).

A physical data collection sheet
Each man was weighed twice in a row by two different people using a scaled person scale. As for the waist circumference (WC), it was measured according to the same procedure as the weight with the help of a microtoise. The mean of the two weighing and the two sizes was retained. The measurement of systolic blood pressure (SBP) and diastolic blood pressure (DBP) was performed twice each. The mean of both was calculated and adopted (Appendix II).

Biological assessment
The blood sample was taken from an antecubital vein of subjects in an extended position and fasting for 12 hours. All the men benefited from biological statements with these parameters: total cholesterol (TC), triglycerides (TG), HDL-cholesterol (HDL-C), blood glucose levels, resistinemia, insulinaemia and leptinemia.

The blood glucose level was determined by enzymatic glucose oxidase method, Beckman kit adapted on "Beckmansynchron Cx9" analyzer. Triglyceride assay was carried out by an enzymatic method, Kit "Beckmansynchron Cx7". As for cholesterol, it was assayed by the enzymatic method to cholesterol oxidase, Beckman kit adapted on "Beckmansynchron Cx9" analyzer. The determination of HDL-cholesterol was carried out by direct assay method with "Randox" Kit adapted on analyzer "Beckmansynchron Cx9". The resistinemia was assayed by the ELISA method "Millipore #EZHR-95K with a sensitivity ranging from 0.16 ng/ml to 10 ng/ml ". Insulinemia was measured by IRMA (Immunoradiometriassay).The leptin assay was performed by the radioimmunoassay method with competition "RIA Millipore # HL-81HK with a sensitivity ranging from 0.5 ng/ml to 100 ng/ml ".

STATISTICAL ANALYSIS

The data were entered using the "Excel version 2007" software and statistical analysis using the SPSS 19.0 software.

Comparison of means
The comparison of two means on independent series (example: an average of obese and control males) were performed by using the Student test for independent series, and in the case of low numbers by the non-parametric test of Mann and Whitney.

Percentage Comparisons
The comparison of percentages on independent series was carried out by the Pearson's chi-square test, and in the case of invalidity, the bilateral Fisher's exact test was used.

Study of links between two quantitative variables
Links between two quantitative variables were studied by the coefficient of Pearson correlation, and in the case of invalidity by a correlation coefficient of ranks of Spearman.
This coefficient is interpreted as follows:
• <0.20: zero or very poor correlation
• 0.21-0.41: Poor correlation
• 0.41-0.60: mean correlation
• 0.61-0.80: good correlation
• 0.81 and above: very good correlation.

Investigation of Risk Factors

Univariate study
For the search for a threshold of resistin and leptin considered as risk factors for obesity associated with the metabolic syndrome, we established a Receiver Operating Curves (ROC) curve for each of these adipokines. This curve was established by studying: sensitivity = f (1-specificity). After verifying that the area under the curve is significantly > 0.50, we chose as the threshold the value of the variable that gives the best pair "sensitivity-specificity". We calculated the Odds ratio (OR), which is the number of times the probability (risk) of an event is multiplied by exposure to a factor as compared to non-exposure.

Multivariate study
To find a direct link between resistin and other parameters, we performed a linear regression analysis using the two-stage top-down method. We introduced resistin as a dependent variable and glycaemia, cholesterol, triglycerides, HDL cholesterol and insulin as explanatory variables. We carried out also a multivariate analysis in logistic regression, where we introduced the disease "obesity with metabolic syndrome" as a dependent dichotomous variable and as explanatory variables insulin, resistin and leptin.
In all the statistical analyzes used, the threshold of significance considered was $P < 0.05$.

RESULTS

As a part of the exploration of possible correlations between resistinemia, leptinemia, blood glucose levels, BMI and various lipid parameters, we performed this comparative study, where we recruited a group of obese subjects with SM and a control group. Both groups include only male subjects.

Characteristics of the study population

As shown in tables 1 and 2, the sample of men studied consisted of 44 obese individuals with metabolic syndrome compared with 35 control men. Both groups come from a very heterogeneous social level and have a varied level of education

Anthropometric parameters

Table 3 presents a comparison of mean age, anthropometric and physical parameters between the obese group with metabolic syndrome and the control group, and table 4 presents a comparison of biochemical and hormonal parameter averages in the two groups.
According to the reported results in both tables, we found that there is a significant difference between the parameters except for the age parameter.

Correlations between anthropometric, biochemical and hormonal parameters

Table 5 presents the correlations between anthropometric, biochemical and hormonal parameters in obese subjects with MS. The plasma concentration of leptin is positively correlated with glycemia, TG, BMI, WC, insulin, SBP, DBP and resistin in the country to HDL-C to which it is negatively correlated. A significant positive correlation was established between resistinemia and BMI for obese patients with MS ($r = 0.659$, p

<0.0001), between resistinemia and waist measurement (r=0.575, p <0.0001).

A significant positive correlation was found between resistinemia and blood glucose in obese patients with MS (r = 0.44, p <0.0001) For blood pressure, a significant positive correlation was established between resistinemia and systolic and diastolic blood pressure, respectively (r = 0.38, p <0.011) and (r = 0.37; p <0.014).

A significant positive correlation was established between resistinemia and triglyceridemia for obese patients with SM (r = 0.545, p <0.0001). There was a significant negative correlation between resistinemia and HDL-C in obese patients with SM (r = -0.47, p <0.001). Also, positive Correlations were established between Resistin and Leptin, Resistin and insulin, Leptin and insulin at the obese group with M S respectively, with (r = 0.75, p <0.001), (r = 0.53, p<0.001), (r = 0.61, p <0.001). Figures 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 illustrate these results.

Search for a threshold of the resistin using the "ROC" curve

We sought a risk threshold for resistinemia using the ROC curve method (Figure 11). We chose as the threshold the value of the variable which gives the best sensitivity-specificity pair which is equal to 8.5 ng/mL (Table 6). We calculated the Odds ratio from Table 6 which represents a good approximation of the relative risk of exposure to obesity with MS. It appears that for resistinemia greater than 8.5 ng/ml, the risk of exposure is high.

Search for a threshold of leptin using the curve "ROC"

We sought a risk threshold for leptinemia using the ROC curve method (Figure 12). We chose as a threshold the value of the variable which gives the best sensitivity-specificity pair which is equal to 10.6 ng/mL. (Table 7) We also calculated the Odds ratio from Table X. It shows that for a leptinemia greater than 10.6ng/ml, the risk of exposure is very high.

RESULTS OF MULTIVARIATE ANALYSIS

We performed a linear regression analysis using the two-stage top-down method. (Table 8).We have introduced resistin as a dependent variable. Glycemia, total cholesterol, triglycerides, HDL-cholesterol, and insulin are used as explanatory variables.

The results show that these parameters are strongly related to each other and therefore all are involved in the genesis of the disease. This analysis is carried out with the aim of seeking a possible difference from the studies carried out with obese patients without metabolic syndrome. After comparing the adipokine and hormone values in the two obese men with SM and control, we performed a logistic regression analysis, introducing the variable "disease" in its dichotomous form and insulin, leptin and resistin as explanatory variables. (Table 9 and 10)

DISCUSSION

Faced with a modernized lifestyle, the expansion of the metabolic syndrome can only increase, giving it a pandemic character. This pathology is considered as a major public health problem given the number and incidence of complications as well as their socioeconomic impact (4, 5). With a rather complex pathophysiology, several factors seem interconnected. For this, we sought the different correlations between different parameters, focusing on leptin and resistin which are two major hormones involved in obesity and MS. Leptin with its satiating effect and resistin with its insulin-resistant effect.

In order to detect the connectivities between the different parameters considered to be related to MS, we calculated the BMI, measured waist circumference, glycaemia, total cholesterol, triglycerides, HDL-C, insulinemia, resistinemia, leptinemia , Systolic and diastolic blood pressure in the two groups of men, then we compared the results found in order to emphasize the possible correlations between these parameters. This study revealed statistically significant differences between the two groups. The lifestyle and the nature of the work performed are involved in the genesis of MS (6).

The results of our study were inconclusive about lifestyle: the percentage of middle managers who were sick was 4.5% compared to control middle managers percentage of 6%, the percentage of workers with MS was 34% compared to 37% of controls. For the educational status, we had 45.5% illiterate patient versus 40% illiterate control subjects and 8.5% of patients with university level compared with 3% of control subjects. Therefore, our results were not conclusive, this is probably due to the limited number of participants in this survey.

However, the comparison table for age averages, anthropometric parameters, SBP and DBP in the two groups showed a significant difference with a P equal to 0.000 for BMI, waist circumference, systolic and diastolic blood pressure. Indeed, these disparities affect, among others, BMI and waist circumference. The obese group with metabolic syndrome had an average BMI of 34.74 kg / m2 and a mean waist circumference of 106.34 cm versus an average BMI of 21.26 kg / m2 and an average mean waist circumference of 79.39 cm in the control group. These two parameters constitute important criteria for the diagnosis of obesity or even the MS and therefore a prediction means of possible complications related to these disorders.

Our results agree well with the literature (7-9). The comparison of biochemical and hormonal parameter averages in the two groups shows that the values of glycemia, TC, TG, Homa-IR, insulin, leptin and resistin were significantly higher in the obese group with a P equal to 0.000. This goes hand in hand with the scientific research of Mehran AE and al. The disorders caused by such a syndrome, mainly central obesity, dyslipidemia with hypertriglyceridemia, hypercholesterolemia and hypo-HDL-cholesterolemia, but also intolerance to glucose which is the consequence of insulin resistance.

Similarly for the study of Ju Young Jung and al. conducted in South Korea on a group of men wherein they attempted to assess the risk of developing MS during hyperinsulinemia. They were able to demonstrate that increased fasting insulin concentration could predict the future development of an MS (10, 11). The increase in HOMA-IR is indicative of insulin resistance. Indeed, during the metabolic syndrome, there is generally an insulin resistance due to the increase of the resistin levels.

The impact of this insulin resistance is the atherogenic effects responsible for the decrease of HDL-C and the hyperglycemia noticed in the obese group with MS. As regards leptin, there was a significant increase in plasma levels of this hormone in the obese group with MS. Let’s emphasize that leptin is an anorectic hormone, it regulates satiety, appetite, food intake, activity, energy expenditure, and its secretion is proportional to the fat mass (12).

Our study also showed that plasma levels of total cholesterol and triglycerides were significantly higher in obese subjects with MS than in control subjects. However, HDL-C is significantly lower in obese patients. This can be explained by insulin resistance and increased plasma insulin levels.

In fact, insulin plays an important role in the regulation of lipid metabolism. On the one hand, it inhibits lipase in the adipose tissues, thus promoting the storage of triglycerides, and reducing the release of fatty acid in the circulation. On the other hand, it inhibits the production of VLDL at the hepatic level (13).

Therefore, during insulin resistance there is a significant lipolysis of the adipocytes with an increase in the flow of free fatty acids in the liver, insulin becomes unable of inhibiting the production of hepatic glucose and the stimulation of the liver lipogenesis continues. This leads to an increase in the production of hepatic triglycerides in the form of VLDL and the transformation of the HDL-C into VLDL then to a non-alcoholic steatosis. All these phenomena lead to hypertriglyceridemia and a decrease in HDL-C (14).

According to our survey, we concluded that there is some correlation between the different parameters.Univariate analysis showed significant differences in hormonal levels of leptin and resistin between the two groups with $p < 0.001$ for resistin and $p < 0.0001$ for leptin. In fact, for the resistin, we found an Odd Ratio (OR) of 23 which is well above 1 indicating a significant difference and a high relative risk (RR).

As for the leptin, the OR was 77, which deduced that the leptin level in the obese group with metabolic syndrome was significantly higher than the control group. Linear regression showed also a strong and direct link between resistinemia and leptinemia with p=0.000. Our results agree well with the work of Ben Slama and al. Of Al-Harithy, and of Silha and al. who found similar outcome (15-17). Extensive research of a direct link between resistin and the various parameters revealed several correlations:

A significant positive correlation was established between resistinemia and BMI for obese patients with MS ($r = 0.659$, $p <0.0001$) and resistinemia and waist circumference ($r = 0.575$, $p <0.0001$). These outcomes match with those found by Al-Harithy and Al-Ghamdi in 2005, who reported higher levels of serum resistin in healthy obese subjects than in non-obese subjects and higher resistin levels in obese diabetic subjects (16).

Mcternan and al. study's conducted in (2002) also reported higher levels of serum resistin in healthy obese subjects compared to non-obese subjects. The studies of Naglaa Azab and al. Conducted in 2012 confirm these results too (18).

In fact, resistin is mainly secreted by white adipose tissue and produced in quantities proportional to the fat mass, therefore the increase in waist circumference and the BMI result in hyperresistinemia (19). As for the multivariate analysis, it shows the existence of a direct link between the BMI and the resistin.

A significant positive correlation was found between resistinemia and blood glucose for obese patients with MS ($r = 0.44$, $p <0.0001$). Studies conducted by Kelishadi.R and al confirm our findings and found that fasting blood glucose is correlated with resistin (20, 21). This can be explained by insulin resistance induced by resistin and which causes hyperglycemia (22). These results are confirmed by Steppan et al. studies' which showed that the addition of recombinant resistin to normal animals causes insulin resistance, while immunoneutralization resistin improves the insulin sensitivity for obese and insulin resistant animals (15, 23, and 24).

Multivariate analysis supports these findings. It shows that there is a direct link between hyperglycemia and resistin. For blood pressure, a significant positive correlation was established between resistinemia and systolic and diastolic blood pressure, respectively ($r = 0.38$, $p <0.011$) and ($r = 0.37$; $p <0.014$).

In fact, the high level of resistin increases the activity of renal and lumbar sympathetic nervous system, suggesting that it can contribute to the increased sympathetic muscular system and reduced energy expenditure observed in subjects with Obesity and diabetes, some clinical studies have shown that circulating resistin levels are associated with hypertension in humans (25-27).

The rise in blood pressure will worsen the MS score. Several mechanisms may contribute to this elevation, such as endothelial dysfunction, which reduces vasodilation, hyperinsulinism with its effects on sodium retention and its properties as a growth factor, secretion of angiotensinogen by adipose tissue (28). Studies conducted by Yun.J and al in 2016 and by Luxia.Z and al in 2010 show that resistin and hypertension are strongly linked, confirming our results (27, 29).

A significant positive correlation was established between resistinemia and triglyceridemia for obese patients with SM ($r = 0.545$, $p <0.0001$). Metabolic syndrome is characterized by quantitative and qualitative lipid abnormalities, which are consistent with the results found in our study and that of Norata and al. (20, 30). Indeed in response to a positive energy balance, the adipocytes increase in size to store excess lipids until they become hypertrophied and become incapable of performing their functions properly. This leads to an increase in the release of fatty acids and TG which will be stored in the ectopic zones thus causing hypertriglyceridemia.

Lipid exchanges by cholesteryl ester transfer protein have been shown to be largely influenced by the concentration of triglyceride-donating lipoproteins. Thus, in the presence of hypertriglyceridemia, increased concentration of large VLDL particles promotes the transfer of TG to LDL and HDL in exchange for cholesteryl ester molecules. As a consequence, both triglyceride enriched LDL and HDL particles of viscerally obese patients become substrates for hepatic triglyceride lipase, leading to the depletion of the lipid core of these lipoproteins, thereby forming small, dense LDL and HDL particles.

Smaller HDL has reduced cholesteryl ester core content and become more sensitive to degradation and increased clearance from the blood (31). All these disorders emphasize the incidence of cardiovascular disorders. There was a significant negative correlation between resistinemia and HDL-C in obese patients with MS ($r = -0.47$, $p <0.001$). The work of Kelishadi.R and al confirms our results (20, 21).

However, neither the multivariate analysis nor the logistic regression was able to confirm this correlation and the direct link between these two parameters. This divergence can be explained by the direct correlation established between resistin and blood glucose, the reflection of which is indirectly correlated to resistinemia and HDL-C. As explained above, resistin causes insulin resistance responsible for the disturbance of the lipid balance.

This discrepancy can also be explained by the direct correlation established between resistin and triglycerides. HDL particles become smaller due to hypertriglyceridemia and are easily degradable, which may partly explain the low level of HDL-C in obese patients with SM (31, 32). The analysis of linear regression by the top-down method that we carried out by introducing resistin as the dependent variable, glycaemia,

cholesterol, triglycerides, HDL cholesterol and insulin as explanatory variables reveals a direct link with leptin, glucose, BMI, and insulin.

Thus, any increase in resistin during obesity with metabolic syndrome results in a variation of these parameters, thus aggravating cardiovascular disorders and accelerating the onset of type 2 diabetes. The logistic regression analysis showed a collinearity between the variables introduced. This means that these variables are very interrelated and provide redundant and therefore repetitive information.

Logistic regression does not reveal two independent variables related to the metabolic syndrome in obese versus non-obese. The positive correlation between resistin, leptin and BMI clearly illustrates the role of adipose tissue in the development of this syndrome and the role of each substance in our body. Each hormone plays a very specific role, but once its rate increases, it becomes harmful and affects the balance of the body.

Given the place of insulin resistance in the metabolic syndrome, it would be interesting to study the relationship between this criterion and other parameters such as leptin and BMI. Our results agree well with data from the literature aside from age because our sample was a group of males matched by age and social level given the size of our sample.

CONCLUSION

The medical community is becoming increasingly aware of the risk of MS. It is a cluster of several metabolic abnormalities namely: abdominal obesity, glucose intolerance, insulin resistance, hypertriglyceridaemia, low HDL- cholesterol and hypertension. As a result, MS is the driving the twin global epidemics of type 2 diabetes and cardiovascular disease.

The purpose of the study was to dose the plasma total cholesterol, triglycerides, HDL-cholesterol, blood glucose levels, resistin, leptin, and insulin. We also compared some physical parameters like BMI, waist circumference, PAS, and PAD. We then attempted to establish correlations between the different parameters by emphasizing the relationships that mainly connect resistin to the rest of the elements through multivariate analysis and linear regression. We found significantly higher rates in the obese group with SM for all parameters except HDL-C.

These variations are in agreement with the complex pathophysiology of MS, which is characterized by an increase in the size of the BMI and fat mass resulting in lipid perturbations and insulin-resistance. We studied the correlations between resistin and lipid parameters (TG and TC), the obtained results showed that there are significantly positive correlations.

However, the existing correlations between resistin and HDL-C are significantly negative, and its rate decreases with increasing VLDL levels. We also performed a multivariate analysis by the top-down method by introducing resistin as a dependent variable. We found that leptin and BMI are predictive parameters of resitinemia, i.e. they are strongly linked and the variation of one results in a change in plasma resistin levels. We also carried out a logistic regression analysis, introducing the variable "disease" in its dichotomous form and insulin, leptin and resistin as explanatory variables. However, this analysis did not reveal two independent variables related to DM in obese versus non-obese.

Our work allowed us to understand several aspects of DM, but our results would be more relevant if our sample size were larger. One of the perspective of this work would be to study the genetic aspect of obesity by focusing on the genes of leptin and resistin receptors.

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ANNEX I : QUESTIONNAIRE

- **General features**

File number : .....

Last name & First Name : .....

- **Occupation :**

Middle manager ☐
State official ☐
Laborer ☐
Liberal function ☐
Unemployed ☐

- **Education level :**

Illiterate ☐
Primary school ☐
High school ☐
University ☐

ANNEX II : DATA COLLECTION SHEET

Date :.....

- **General features**

File number : .....

Last name & First Name : .....

Age : .....

- **Personal pathological history**

Hypertension : yes ☐ No ☐

Cardiovascular disease: yes ☐ No ☐

- **Anthropometric measurements**

Weight (kg) : .....

Height (m) : .....

BMI (kg/m^2) : .....

Waist circumference :……

- **Biochemical parameters**

HDL-cholesterolemia (mmol/l) : .....

Cholesterolemia (mmol/l) : .....

Triglyceridemia (mmol/l) : .....

Glycaemia (mmol/l) : .....

Insulinemia (µUI/l) : .....

Resistinemia (ng/ml) : .....

Leptinemia (ng/ml) : …….

- **Physical parameters**

SBP : ……..

DBP : ……

Table 1: Occupation of Men in Both Groups

Occupation	Medical condition			
	Obese with MS		Controls	
	Number	Percentage	Number	Percentage
Middle manager	2	4,5%	2	6%
State official	11	25%	8	23%
Worker	15	34%	13	37%
Liberal function	4	9%	4	11%
Unemployed	12	27,5 %	8	23%
Total	44	100%	35	100%

Table 2: Education Level of men in both groups

Education Level	Medical condition			
	Obese		Controls	
	Number	Percentage	Number	Percentage
Illiterate	20	45,5%	14	40%
Primary school	14	32%	12	34%
Secondary school	6	14%	8	23%
University	4	8,5%	1	3%
Total	44	100%	35	100%

Table 3: Comparison of age averages, anthropometric parameters in the obese group with Metabolic Syndrome and the control group

Anthropometric parameters		N	Mean	Standard deviation	P
Age (year)	**Obese+MS**	44	50,55	6,048	0,884
	Controls	35	50,74	5,863	
BMI (kg/m^2)	**Obese+MS**	44	34,7457	4,23919	**0,000**
	Controls	35	21,2674	1,51095	
WC (cm)	**Obese+MS**	44	106,34	9,705	**0,000**
	Controls	35	79,39	5,423	
SBP (mm Hg)	**Obese+MS**	44	141,48	9,740	**0,000**
	Controls	35	123,17	3,494	
DBP (mm Hg)	**Obese+MS**	44	89,50	4,061	**0,000**
	Controls	35	79,49	4,104	

BMI: Body mass index, WC waist circumference, SBP: systolic blood pressure, DBP: diastolic blood pressure

Table 4: Comparison of biochemical and hormonal parameters averages in the two groups

Biochemical and hormonal parameters		N	Mean	Standard deviation	P
Gly (mmol/L)	**Obese + MS**	44	7,3005	1,24305	**0,000**
	Controls	35	5,0111	0,30746	
TC (mmol/L)	**Obese + MS**	44	5,4743	1,09088	**0,000**
	Controls	35	4,2497	0,65969	
TG (mmol/L)	**Obese + MS**	44	1,8898	0,23907	**0,000**
	Controls	35	1,0226	0,53910	
HDL-C (mmol/L)	**Obese + MS**	44	0,7670	0,15310	**0,000**
	Controls	35	1,1400	0,14951	
Insulin (pmol/L)	**Obese + MS**	44	14,1748	4,76275	**0,000**
	Controls	35	5,1237	1,99986	
Leptin (ng/ml)	**Obese + MS**	44	17,9018	4,80853	**0,000**
	Controls	35	5,5866	2,44254	
Résistin (ng/ml)	**Obese + MS**	44	9,8536	1,46744	**0,000**
	Controls	35	2,3309	2,85126	
Homa-IR	**Obese + MS**	44	4,7665	2,30344	**0,000**
	Controls	35	1,1543	0,49574	

Gly: Glycemia TC: total cholesterol, TG: triglyceride, HDL-C: HDL cholesterol

Table 5: Correlations between anthropometric, biochemical and hormonal parameters

		Gly	TC	TG	HDL-C	BMI	WC	SBP	DBP	Insulin	leptin	Résistin
Gly	Pearson's corrélation	1	0,005	0,184	-0,226	**0,575 (**)**	**0,185**	**0,370 (*)**	**0,353 (*)**	**0,650 (**)**	**0,574 (**)**	**0,442 (**)**
	Sig. (bilateral)	,	0,977	0,232	0,140	0,000	0,229	0,013	0,019	0,000	0,000	0,003
TC	Pearson's corrélation	0,005	1	**0,399 (**)**	**-0,331 (*)**	**0,432 (**)**	**0,429 (**)**	0,140	0,128	0,144	0,286	**0,586 (**)**
	Sig. (bilateral)	0,977	,	0,007	0,028	0,003	0,004	0,365	0,407	0,352	0,060	0,000
TG	Pearson's corrélation	0,184	**0,399 (**)**	1	-0,135	**0,547 (**)**	**0,543 (**)**	**0,519 (**)**	**0,564 (**)**	0,018	**0,298 (*)**	**0,545 (**)**
	Sig. (bilateral)	0,232	0,007	,	0,383	0,000	0,000	0,000	0,000	0,910	0,050	0,000
HDL-C	Pearson's corrélation	-0,226	**-0,331 (*)**	-0,135	1	-0,249	-0,238	-0,251	-0,066	**-0,340 (*)**	**-0,468 (**)**	**-0,470 (**)**
	Sig. (bilateral)	0,140	0,028	0,383	,	0,104	0,119	0,100	0,668	0,024	0,001	0,001
BMI	Pearson's corrélation	**0,575 (**)**	**0,432 (**)**	**0,547 (**)**	-0,249	1	**0,464 (**)**	**0,608 (**)**	**0,448 (**)**	**0,307 (*)**	**0,513 (**)**	**0,659 (**)**
	Sig. (bilateral)	0,000	0,003	0,000	0,104	,	0,002	0,000	0,002	0,043	0,000	0,000

Table 6: Correlations between anthropometric, biochemical and hormonal parameters (sequel)

		Gly	TC	TG	HDL-C	BMI	WC	SBP	DBP	Insulin	leptin	Résistin
WC	Pearson's corrélation	0,185	**0,429 (**)**	**0,543 (**)**	-0,238	**0,464 (**)**	1	**0,494 (**)**	**0,533 (**)**	0,218	**0,410 (**)**	**0,575 (**)**
	Sig. (bilateral)	0,229	0,004	0,000	0,119	0,002	,	0,001	0,000	0,156	0,006	0,000
SBP	Pearson's corrélation	**0,370 (*)**	0,140	**0,519 (**)**	-0,251	**0,608 (**)**	**0,494 (**)**	1	**0,839 (**)**	0,164	**0,321 (*)**	**0,380 (*)**
	Sig. (bilateral)	0,013	0,365	0,000	0,100	0,000	0,001	,	0,000	0,288	0,033	0,011
DBP	Pearson's corrélation	**0,353(*)**	0,128	**0,564 (**)**	-0,066	**0,448 (**)**	**0,533 (**)**	**0,839 (**)**	1	0,242	**0,322 (*)**	**0,369 (*)**
	Sig. (bilateral)	0,019	0,407	0,000	0,668	0,002	0,000	0,000	,	0,114	0,033	0,014
Insulin	Pearson's corrélation	**0,650 (**)**	0,144	0,018	**-0,340 (*)**	**0,307 (*)**	0,218	0,164	0,242	1	**0,605 (**)**	**0,526 (**)**
	Sig. (bilateral)	0,000	0,352	0,910	0,024	0,043	0,156	0,288	0,114	,	0,000	0,000
leptin	Pearson's corrélation	**0,574 (**)**	0,286	**0,298 (*)**	**-0,468 (**)**	**0,513 (**)**	**0,410 (**)**	**0,321 (*)**	**0,322 (*)**	**0,605 (**)**	1	**0,753 (**)**
	Sig. (bilateral)	0,000	0,060	0,050	0,001	0,000	0,006	0,033	0,033	0,000	,	0,000
Résistin	Pearson's corrélation	**0,442 (**)**	**0,586 (**)**	**0,545 (**)**	**-0,470 (**)**	**0,659 (**)**	**0,575 (**)**	**0,380 (*)**	**0,369 (*)**	**0,526 (**)**	**0,753 (**)**	1
	Sig. (bilateral)	0,003	0,000	0,000	0,001	0,000	0,000	0,011	0,014	0,000	0,000	,

*The correlation is significant at 0.05 (bilateral)

**The correlation is significant at the 0.01 (bilateral

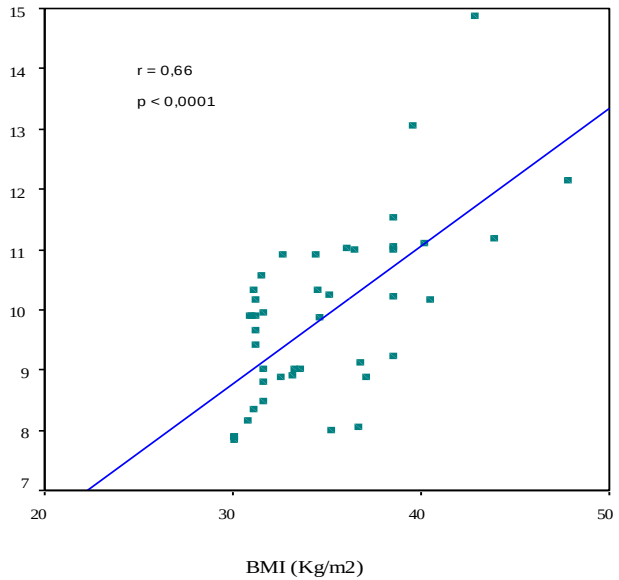

Figure 1: Correlation between Resistin and BMI at the obese group with MS

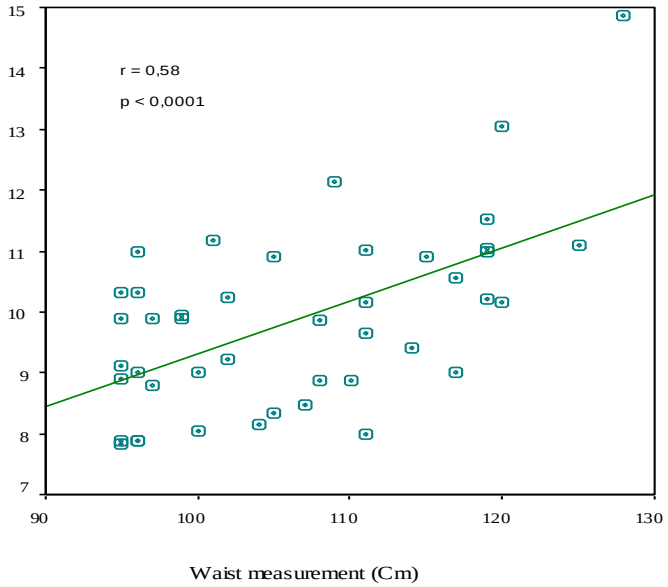

Figure 2: Correlation between Resistin and Waist measurement at the obese group with MS

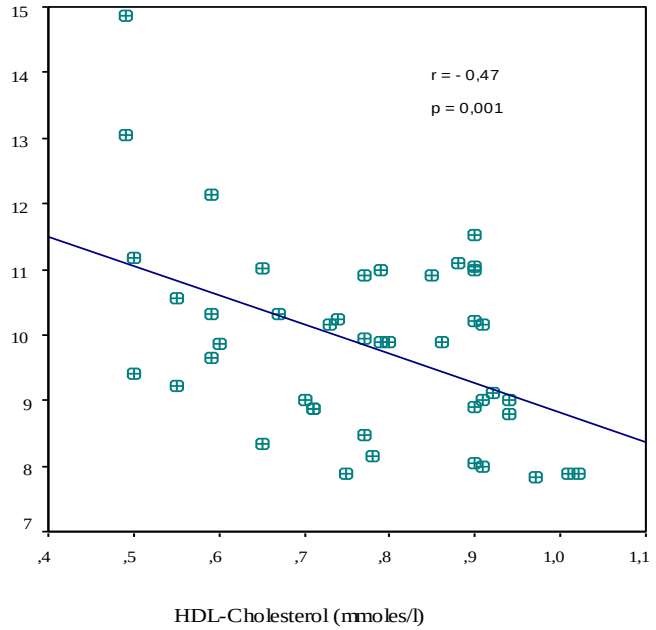

Figure 3: Correlation between Resistin and Hdl-Cholesterol at the obese group with MS

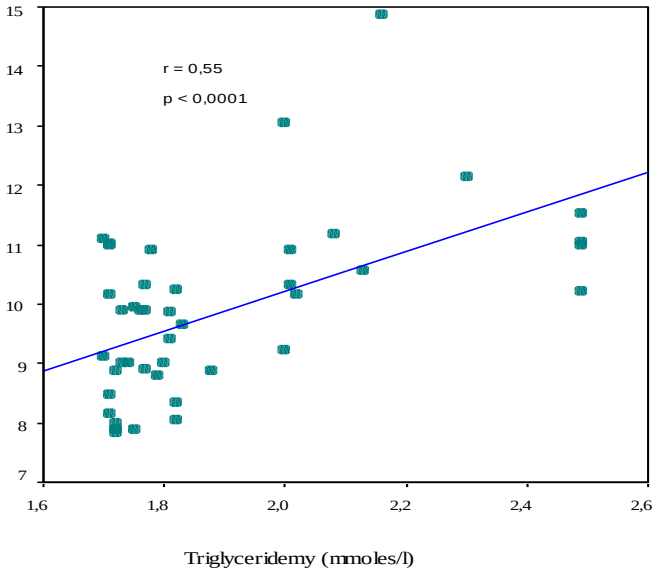

Figure 4: Correlation between Resistin and Triglyceridemy at the obese group with MS

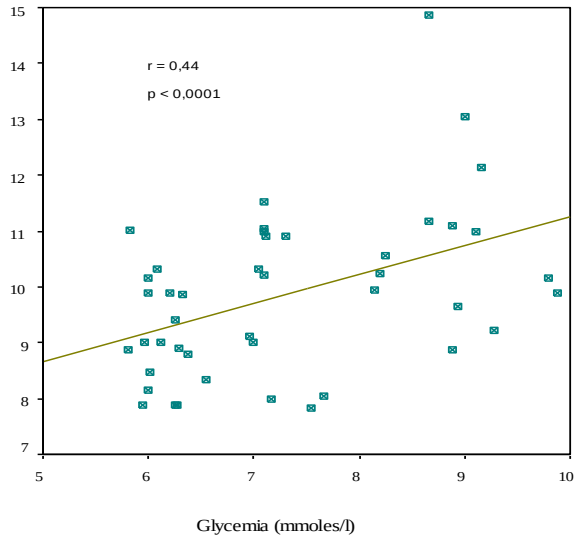

Figure 5: Correlation between Resistin and Glycemia at the obese group with MS

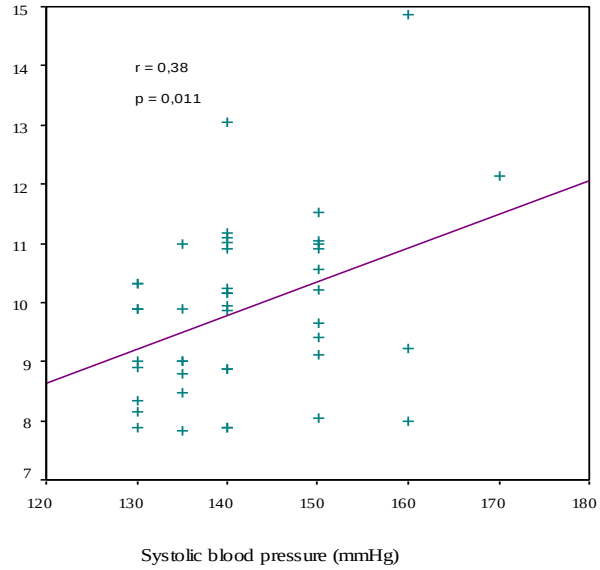

Figure 6: Correlation between Resistin and Systolic blood pressure at the obese group with MS

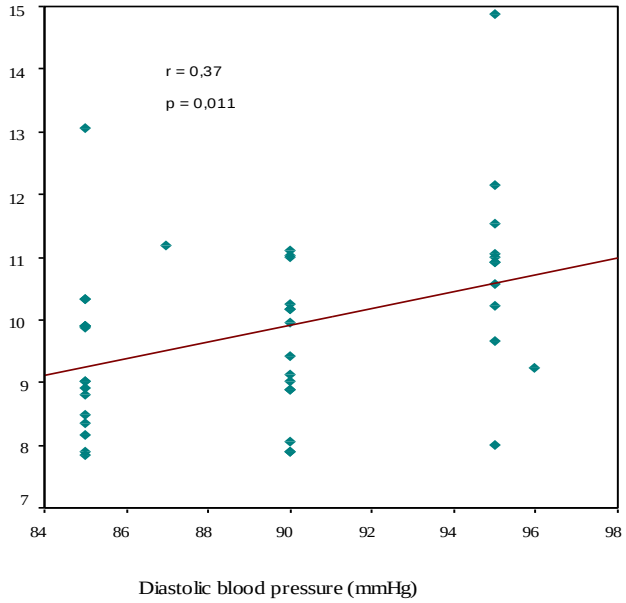

Figure 7: Correlation between Resistin and Diastolic blood pressure at the obese group with MS

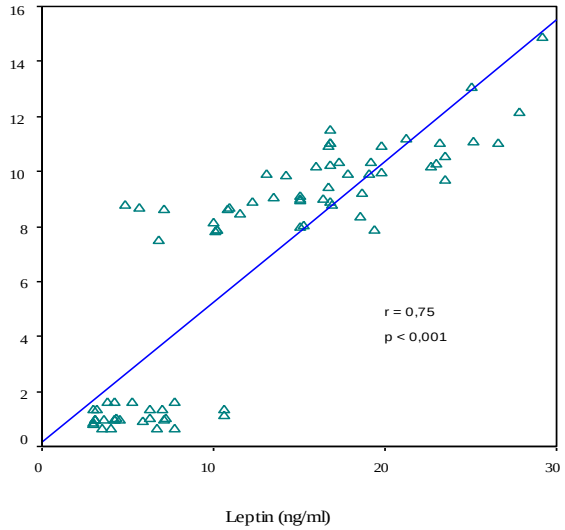

Figure 8: Correlation between Resistin and Leptin at the obese group with MS

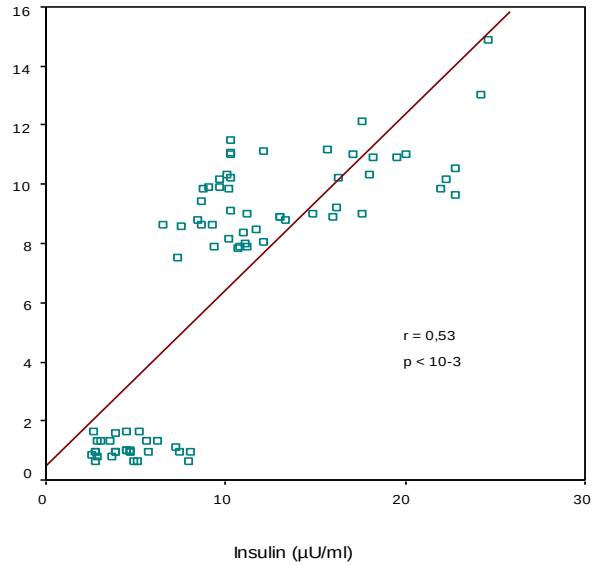

Figure 9: Correlation between Resistin and insulin at the obese group with MS

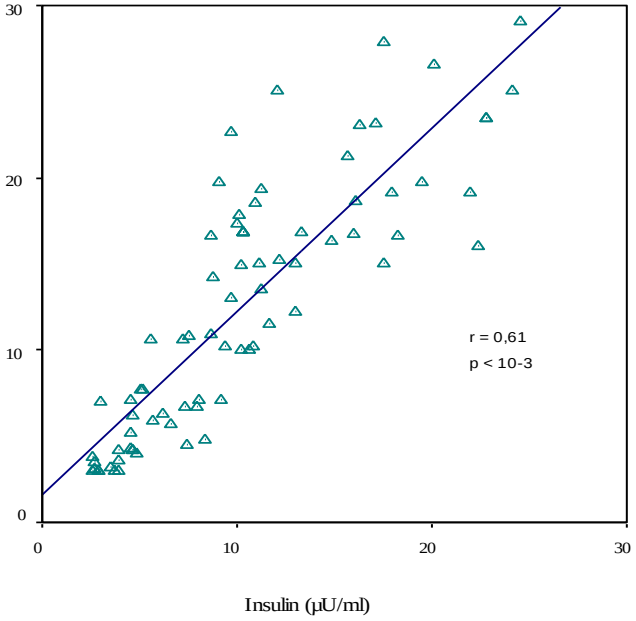

Figure 10: Correlation between Leptin and insulin at the obese group with M

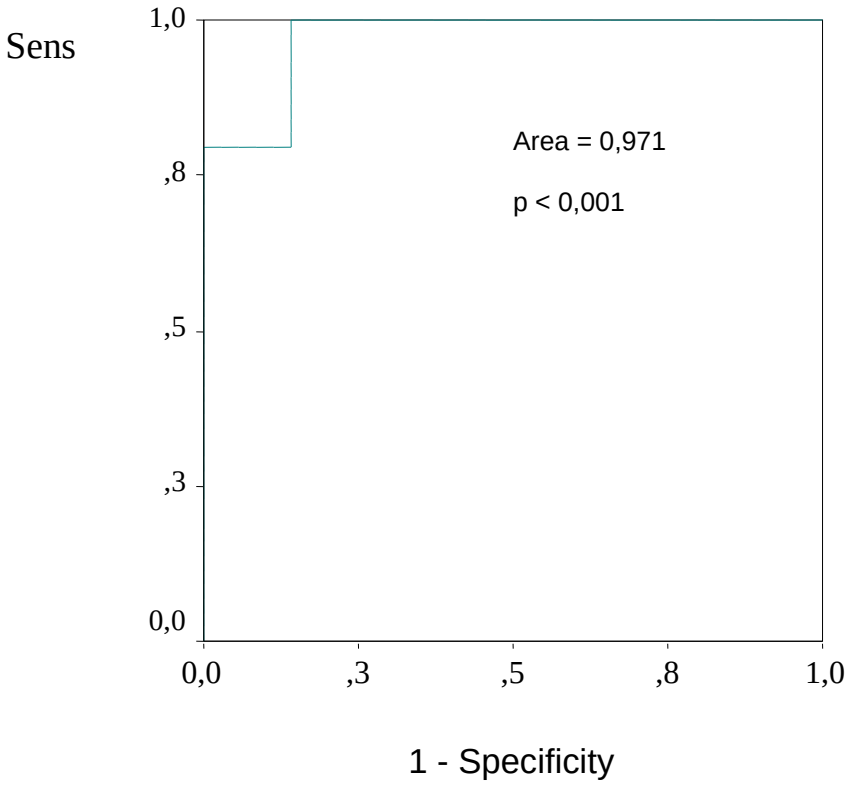

Figure 11: ROC curve Search for a threshold value for resistenemia

Table 6: Cross table Threshold of resistinemia

Threshold of resistinemia 8,5 ng/ml	Medical condition			
	obese + S M		Controls	
	Number	Percentage	Number	Percentage
>= 8,5 ng/ml	35	79,5%	5	14,3%
< 8,5 ng/ml	9	20,5%	30	85,7%
Total	44	100,0%	35	100,0%

X^2 = 33,21 ; p < 0,001 ; OR = 23 ; IC : [7, 77]

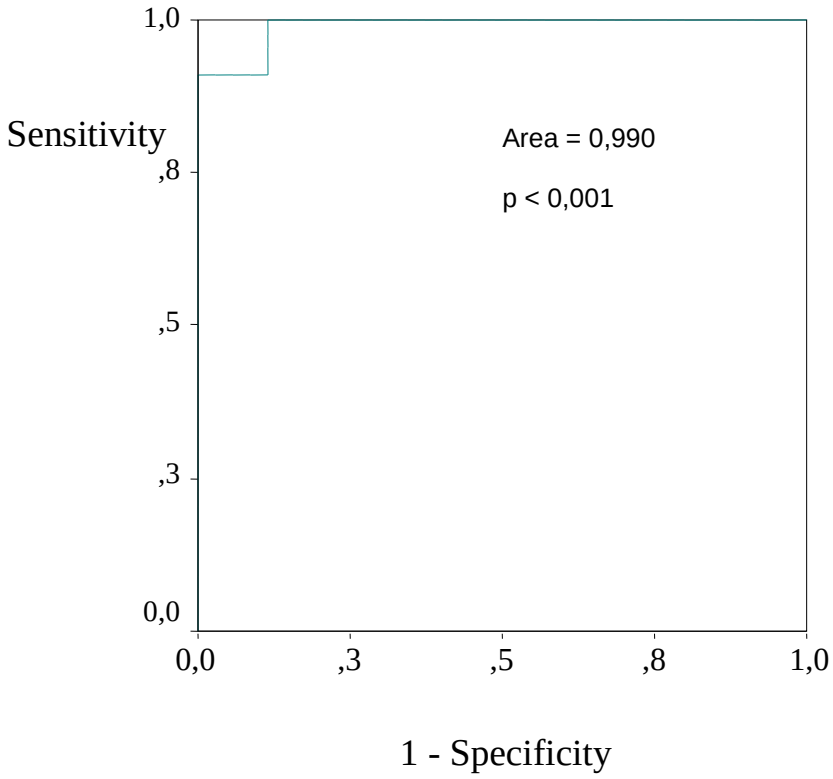

Figure 12: ROC curve Search for a threshold value for Leptinemia

Table 7: Cross table Threshold of leptinemia

Threshold of leptinemia 10,6 ng/ml	Medical condition			
	obese + S M		Controls	
	Number	Percentage	Number	Percentage
>= 10,6 ng/ml	40	90,9%	4	11,4%
< 10,6 ng/ml	4	9,1%	31	88,6%
Total	44	100,0%	35	100,0%

X2 = 49,9 ; p < 0,001 ; OR = 77 ; IC : [17, 335]

Table 8: Analysis of linear regression

Explanatory variable		P
Model 1	(constant)	0,012
	GLYCEMIA	0,037
	HDL-CHOL	0,257
	BMI	0,000
	INSULIN	0,061
	LEPTIN	0,001
Model 2	(constant)	0,017
	GLYCEMIA	0,026
	BMI	0,000
	INSULIN	0,042
	LEPTIN	0,000

Table 9: Test de Hosmer-Lemeshow

Steps	Khi-two	Degrees of freedom	Signification
1	0,000	7	1,000
2	0,000	6	1,000
3	0,000	6	1,000

Table 10: variables of equation

	B	E.S.	Wald	Degrees of freedom	Signification
Step 1(a)	-2,111	2473,220	0,000	1	,999
	-7,653	1994,985	0,000	1	,997
	-1,640	883,415	0,000	1	,999
	95,253	11667,097	0,000	1	,993
Step 2(a)	-9,313	922,625	0,000	1	,992
	-1,976	832,038	0,000	1	,998
	93,417	8617,806	0,000	1	,991
Step 3(a)	-13,898	942,750	0,000	1	,988
	124,058	8447,144	0,000	1	,988

A: Variable (s) entered in step 1: INSULIN, LEPTINE, RESISTIN. / E.S: Standard Error