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Original Article

Equality or disparity? Cardiovascular risk factors and their correlation within the metabolic syndrome. The secret of gods

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ABSTRACT

Aims: The primary objective of our study is to determine the prevalence of the metabolic syndrome in the population. The secondary objective is to determine the prevalence of cardiovascular risk factors and their correlation with the metabolic syndrome.
Material and methods: The sample for the study was obtained by means of a consecutive population-based demonstration in 803 adults over 18 years of age belonging to the labor force of the company Grupo Delta SA. The study was carried out according to the guidelines of the Declaration of Helsinki. The individuals included in the study voluntarily participated, once informed of the purpose of the study, giving their prior verbal consent, to the company's human resources department, in the case of Delta Group workers.
Results: 23.8% of the population has metabolic syndrome. Each cardiovascular risk factor has different importance in the metabolic syndrome.
Conclusion: The correlation of cardiovascular risk factors with the metabolic syndrome differs from one another.

1. Introduction

Metabolic syndrome (MS) is recognized by a set of cardiovascular risk factors that usually coincide with insulin resistance and hyperglycemia. The modified National Cholesterol Education Program Adult Treatment Panel III (NCEP/ATP III) (NCEP/ATP III) criteria were used for the diagnosis of the metabolic syndrome [1,2]. A person who had three or more of the following risk components was considered to have MS: fasting glucose greater than 100 mg/dl or on antidiabetic medication [1], high blood pressure (SAD ≥130 mmHg and TAD≥85 mmHg) or on antihypertensive medication, triglycerides increase (≥150 mg/dl) or on antihyperlipidemic medication, decreased HDL levels <40 mg/dl in men or < 50 mg/dl in women) and central obesity (waist circumference ≥102 cm in men and ≥88 cm in women) [3]. Some affected persons are more prone to hypertension, others to dyslipidemia or diabetes. Influences on development of individual risk factors also vary, and these must be factored into the pathogenic sequence of the syndrome [4]. Since this syndrome consists of known cardiovascular risk factors, in which the effect of the different factors is synergistic and multiplicative, greatly amplifying the effects of each, it is often not possible to make a cause-effect relationship between some risk factors and MS. (see Figs. 1 and 2).

Thus, the primary objective of our study is to determine the prevalence of the metabolic syndrome in the North Alentejo. The secondary objective is to determine the prevalence of cardiovascular risk factors and their correlation with the metabolic syndrome.

The interest of the investigation that arises is based on the need to know the prevalence of the metabolic syndrome in Portuguese active population of an area with an important load of Cardiovascular Risk Factors, since patients with MS have an increased risk of developing cardiovascular disease over a period of 5 years. Knowledge of the relationship between cardiovascular risk factors and the metabolic syndrome may allow establishing priorities in their prevention and treatment.

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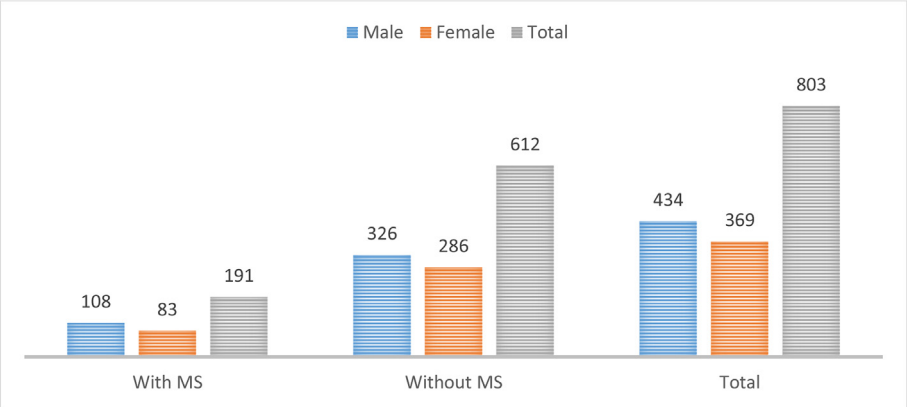

Fig. 1. Distribution of persons by sex and with or without MS.

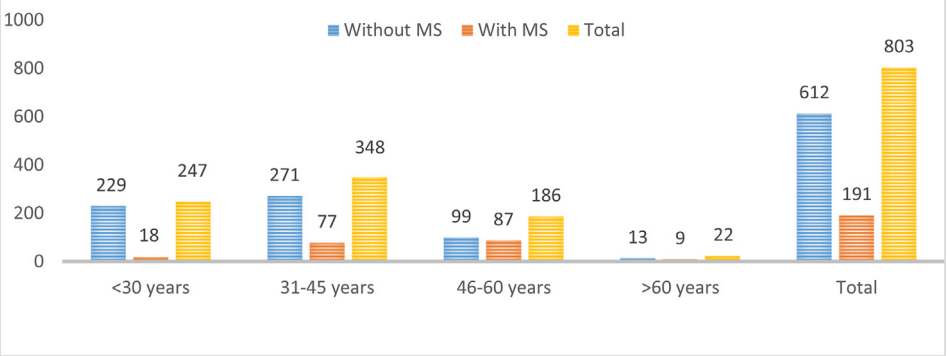

Fig. 2. Distribution of persons by age with and without Ms.

2. Materials and methods

2.1. Subjects

The sample for the study will be obtained by consecutive demonstration. The selection of the sample will include patients older than 18 years who work in Grupo Delta S.A.

Exclusion criteria were concomitant serious diseases that may cause alterations in nutritional status: active or curative neoplastic diseases less than 6 months old, eating disorders (bulimia or anorexia), inflammatory bowel disease, pregnant women, terminal patients, advanced renal, hepatic or cardiac insufficiency, dehydration states.

All sample members will be asked to sign an informed consent for inclusion in the study.

An anamnesis will be conducted to investigate smoking habits, exercise habits, previous pathophysiological conditions, family and personal history of cardiovascular diseases.

Both systolic and diastolic blood pressure (SBP and DBP) will be evaluated with a digital sphygmomanometer validated in three serial determinations, after which the arithmetic mean will be discovered.

2.2. Laboratory assays

In addition, the following biochemical parameters will be determined in the Santa Luzia Hospital of Elvas laboratory: hemogram, renal and hepatic profile, total cholesterol, HDL cholesterol, LDL cholesterol, basal glycemia, fasting insulinemia, HbA1c, uric acid, Albuminuria.

2.3. Statistical analysis

In addition to the descriptive statistics procedures, the Student's *t*-test will be performed in order to study the differences between the sexes with respect to the quantitative variables. The univariate association between quantitative variables will be explored through the Pearson correlation model. The multivariate analysis will be performed following the multiple linear regression model. Any level of $p < 0.05$ will be considered significant. For statistical analysis SPSS software for Windows will be used.

3. Results

The sample of this work is made up of 803 people, of which 434 (54%) are female and 369 are male (46%). 23.8% of people were diagnosed with metabolic syndrome and 56.5% (n = 108) are men (Graphic 1). The ages vary between 18 and 75 years, with a mean age of 44.62, with the standard deviation of 10.27.

Of the individuals in the sample, 43.3% (n = 348) were between 31 and 45 years of age, followed by the group with less than 30 years, corresponding to 30.7% of the people (n = 247), then age groups between the ages of 46 and 60 (23.1%), and finally individuals over 60 (2.7%) (Graphic 2).

In the groups with MS, we found that the majority had obesity (46.3%) or overweight (40.5%), with only 13.2% of those with BMI below 25 kg/m2. In the group without MS, 48.1% had a BMI lower than 25 kg/m2, 41.3% were overweight and 10.6% had a BMI greater than 30 kg/m2 (Table 1).

In relation to the Chi-Square values (×2), we noted the existence of statistically significant differences (**p < 0.01) and highly

Table 1
Socio-demographic characterization of the sample.

Metabolic syndrome	No			Yes			Total		Qui Quadrado (X^2)
Variables	N (612)	% (76.2)	Resid.	N (191)	% (23.8)	Resid.	N (803)	% (100.0)	
Body Mass Index									
Thinness (IMC<20 kg/m^2)	28	4.6	1.1	2	1.1	−1.9	30	3.7	
Normal (20−25 kg/m^2)	266	43.5	3.1	23	12.1	−5.5	289	36.0	
Over weight (25−30 kg/m^2)	253	41.3	0.1	77	40.5	−0.1	330	41.1	
Obesity (IMC>30 kg/m^2)	65	10.6	−4.8	88	46.3	8.6	153	19.1	0.000***

significant (***p < 0.001) between MS and HT, diabetes, Dyslipidemia, hyperuricemia (Table 2). This occurs in the clinical/analytical variable parameters, with higher means in all the parameters and variables analyzed, by the individuals without SM (Table 3).

In men, high blood pressure (72.1%), followed by hypertriglyceridemia (40.8%), high blood glucose (22.8%), and high waist circumference (20.5%) were the most frequent criteria and lastly the low levels of HDL cholesterol (5%). Women also had high blood pressure (47.2%), followed by increased waist circumference (38.7%), low HDL cholesterol (38.5%), hypertriglyceridemia (38%), and finally hyperglycemia (15.1%) (Table 4).

After the descriptive analysis of the data obtained previously, we will focus on the inferential analysis of them. We proceed to the verification of the validity of the working hypothesis, associating some independent variables in the study, to our dependent variable. In our study, we emphasize that individuals with MS have higher means in ALL parameters evaluated, with the exception of smoking habits that are dominated by respondents without metabolic syndrome. There are thus very significant statistical differences (**p < 0.01), and highly significant (***p < 0.001) in some of the variables indicated. Regarding the quantitative variables, men presented higher means in most of the parameters evaluated, except for hip diameter, total cholesterol, HDL-c, LDL-c, fibrinogen, CRP, urea and of creatinine, which are dominated by women. There are thus statistically significant differences (*p < 0.05), very significant (**p < 0.01) and highly significant (***p < 0.001) in some indicated variables. (Table 5).

We see that independent variables (quantitative) significantly predict the occurrence of MS. To study the multivariate hypothesis, we perform a multiple linear regression, in which the following table presents the last obtained regression model, which shows that there are 7 variables that enter this regression model, thus constituting SM predictors. . The correlation that these variables establish with the SM is strong (r = 0.832) explaining as a whole (69.0%) the variation of the SM.

Fisher's F tests are all statistically significant, which leads to the acceptance of the correlation force between the variables under study. The values of t, when they present statistical significance, allow us to affirm that the independent variables that have entered the regression model have explanatory power in the SM, since the coefficients of each one are far from zero.

Finally, by the standardized beta coefficients, we noticed that triglycerides, glycemia and SBP are the ones with the highest predictive value, with HDL-c emerging in the last position. It can be considered that all these variables referred to above establish a direct relationship with the SM (Table 6).

The final model adjusted to explain part of the Metabolic Syndrome is provided by the following formula: (69.0%) of the Metabolic Syndrome (score) = −3493 + 0.261 Waist diameter + 0.365 Triglycerides + 0.303 Glicemia +0.297 Systolic TA - 0.093 wt + 0.105 Diameter of the hip - 0.054 HDL-c.

4. Discussion

Making an analysis through the Chi-square test can establish the association between the number of verified criteria and age (p = 0.000), being appreciated that this one correlates positively with the metabolic syndrome; thus, the older, the higher the probability of meeting more criteria.

We verified that the variable that has the greatest influence on the occurrence of MS are triglycerides. The VALSIM study [5] finds that the most frequent component was high blood pressure, present in 56.96% among carriers of MS. This difference can be explained due to differences in food between regions. The high-fat diet in the northern Alentejo region may explain the elevated levels of triglycerides. It can also be explained by a greater prevention and control of arterial hypertension in the north of the Alentejo. However, there are no studies in the region that can prove these theories, and further studies are needed.

To study the quantitative variables of our study, and the relationship with sex we used Student's T test, where we highlight that male individuals have higher means in most of the evaluated

Table 2
Characterization of the risk factors of the sample according to the subgroups with and without MS.

Metabolic syndrome	No			yes			Total		Qui Quadrado (X^2)
Variables	N (612)	% (76.2)	Resid.	N (191)	% (23.8)	Resid.	N (803)	% (100.0)	
Hypertension									
No	561	91.7	1.6	127	66.5	−2.9	688	85.7	
Yes	51	8.3	−3.9	64	33.5	7.0	115	14.3	0.000***
Diabetes									
No	605	98.9	0.3	179	93.7	−0.5	784	97.6	
Yes	7	1.1	−2.0	12	6.3	3.5	19	2.4	0.000***
Family history of CV disease									
No	520	85.0	0.2	157	82.2	−0.3	677	84.3	
Yes	92	15.0	−0.4	34	17.8	0.7	126	15.7	0.358 (ns)
Dyslipidemia									
No	519	84.8	1.2	127	66.5	−2.2	646	80.4	
Yes	93	15.2	−2.4	64	33.5	4.4	157	19.6	0.000***
Hyperuricemia									

Table 3
Statistics related to the clinical/analytical variables according to the existence or not of the metabolic syndrome.

Variables	Metabolic syndrome	Min	Max	Media	D.P.
Systolic Tension (mmHg)	No	85	242	129,39	18,33
	yes	93	204	**148,07**	18,36
	Total	85	242	133,83	19,98
Diastolic Tension (mmHg)	No	50	124	80,15	10,78
	yes	55	115	**89,04**	10,15
	Total	50	124	82,26	11,28
Glycemia (mg/dl)	No	56	262	88,49	18,82
	yes	61	249	**109,95**	28,43
	Total	56	262	93,59	23,34
Total cholesterol (mg/dl)	No	105	520	174,10	31,05
	yes	133	520	**201,38**	44,03
	Total	105	520	180,59	36,45
HDL (mg/dl)	No	16	88	54,39	11,27
	yes	29	84	54,47	10,95
	Total	16	88	54,41	11,19
LDL (mg/dl)	No	15,80	413,40	92,17	31,63
	yes	32,40	393,20	93,23	43,98
	Total	15,80	413,40	92,42	34,94
Triglycerides (mg/dl)	No	70	563	141,18	87,06
	yes	70	582	**269,49**	125,75
	Total	70	582	171,70	111,85
Uric acid (mg/dl)	No	2	10	5,40	0,976
	yes	4	9	5,81	0,998
	Total	2	10	5,50	0,996
Fibrinogen (mg/dl)	No	159	487	284,60	66,07
	yes	142	536	**322,70**	87,59
	Total	142	536	293,67	73,53
PCR (mg/dl)	No	0,01	2,58	0,40	0,40
	yes	0,02	2,88	**0,58**	0,62
	Total	0,01	2,88	0,44	0,47
Urea (mg/dl)	No	12	119	36,48	9,09
	yes	15	95	36,95	9,09
	Total	12	119	36,59	9,09
Creatinine (mg/dl)	No	0,36	4,20	0,77	0,25
	yes	0,39	2,22	0,77	0,23
	Total	0,36	4,20	0,77	0,25
Microalbuminuria (mg/dl)	No	0	56	1,42	6,50
	yes	0	100	**2,09**	10,15
	Total	0	100	1,58	7,53
RCV (mg/dl)	No	0,03	33,57	3,42	3,90
	yes	0,07	37,32	**9,20**	7,35
	Total	0,03	37,32	4,79	5,52

Table 4
Distribution by sex of the criteria of metabolic syndrome among the participants with this diagnosis.

	Men	Women
Abdominal circumference $\geq$ 102 cm (men) or $\geq$ 88 cm (women)	20.5%	38.7%
Hdl-c < 40 mg/dl (men) or < 50 mg/dl (women)	5%	38.5%
Fasting glycemia $\geq$100 mg/dl or pharmacological treatment	22.8%	15.1%
Tryglicerides $\geq$ 150 mg/dl	40.8%	38%
Systolic hypertension $\geq$ 130 or diastolic hypertension $\geq$ 85 mmhg or pharmacological treatment	72.1%	47.2%

parameters, with the exception of the diameter of the hip, of the cholesterol total, HDL-c, LDL-c, fibrinogen, CRP, urea and creatinine, which are dominated by female respondents. Despite being higher in women than in men, there is no statistically significant difference. This factor represents the universal presence of these factors in both sexes, thus there are statistically significant differences ($^{*}p < 0.05$); very significant ($^{**}p < 0.01$); and highly significant ($^{***}p < 0.001$) in some indicated variables.

Among the independent (quantitative) variables that significantly predict the occurrence of the metabolic syndrome, we perform a multiple linear regression which shows that 7 variables are included in this model of regression, thus constituting predictors of SM score. The correlation that these variables establish with the SM is strong ($r = 0.832$), explaining as a whole 69.0% of the variation of the metabolic syndrome. These factors are in accordance with the literature worldwide. The F tests are all statistically significant, which leads to acceptance of the strength of association between the variables under study. The values of t present statistical significance, allowing to affirm that the independent variables that have entered the regression model have explanatory power in the SM, since the coefficients of each one are far from zero. Finally, due to the standardized beta coefficients, we observed that triglycerides, glycaemia and SBP are the ones with the highest predictive value, with HDL-c emerging last. It can be considered that all these variables referred to above establish a direct relationship with the metabolic syndrome score.

5. Conclusion

24% of the analyzed sample presents SM criteria, being more

Table 5
Statistics related to the clinical/analytical variables according to the existence or not of the metabolic syndrome.

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Systolic Tension (mmHg)	No	85	242	129,39	18,33
	yes	93	204	**148,07**	18,36
	Total	85	242	133,83	19,98
Diastolic Tension (mmHg)	No	50	124	80,15	10,78
	yes	55	115	**89,04**	10,15
	Total	50	124	82,26	11,28
Glycemia (mg/dl)	No	56	262	88,49	18,82
	yes	61	249	**109,95**	28,43
	Total	56	262	93,59	23,34
Total cholesterol (mg/dl)	No	105	520	174,10	31,05
	yes	133	520	**201,38**	44,03
	Total	105	520	180,59	36,45
HDL (mg/dl)	No	16	88	54,39	11,27
	yes	29	84	54,47	10,95
	Total	16	88	54,41	11,19
LDL (mg/dl)	No	15,80	413,40	92,17	31,63
	yes	32,40	393,20	93,23	43,98
	Total	15,80	413,40	92,42	34,94
Triglycerides (mg/dl)	No	70	563	141,18	87,06
	yes	70	582	**269,49**	125,75
	Total	70	582	171,70	111,85
Uric acid (mg/dl)	No	2	10	5,40	0,976
	yes	4	9	5,81	0,998
	Total	2	10	5,50	0,996
Fibrinogen (mg/dl)	No	159	487	284,60	66,07
	yes	142	536	**322,70**	87,59
	Total	142	536	293,67	73,53
PCR (mg/dl)	No	0,01	2,58	0,40	0,40
	yes	0,02	2,88	**0,58**	0,62
	Total	0,01	2,88	0,44	0,47
Urea (mg/dl)	No	12	119	36,48	9,09
	yes	15	95	36,95	9,09
	Total	12	119	36,59	9,09
Creatinine (mg/dl)	No	0,36	4,20	0,77	0,25
	yes	0,39	2,22	0,77	0,23
	Total	0,36	4,20	0,77	0,25
Microalbuminuria (mg/dl)	No	0	56	1,42	6,50
	yes	0	100	**2,09**	10,15
	Total	0	100	1,58	7,53
RCV (mg/dl)	No	0,03	33,57	3,42	3,90
	yes	0,07	37,32	**9,20**	7,35
	Total	0,03	37,32	4,79	5,52

Table 6
Multiple linear regression between the Metabolic Syndrome score and the independent variables (predictors).

Dependent variable: Occurrence of the Metabolic Syndrome (indicator score)					
R = 0.832					
R2 = 0.693					
R2 Adjusted = 0.690					
Estimation error pattern = 0,621					
F = 256,217					
P = 0.000***					
Regression Weights					
Independent variables Coefficient	beta	Standardized coefficient	t	P	
Constant	−3943		−8052	0,000***	
Diameter of the waist	0,025	0261	7529	0,000***	
Triglycerides	0,004	0365	17,866	0,000***	
Glycemia	0,014	0303	14,949	0,000***	
Systolic TA	0,017	0297	13,538	0,000***	
Weight	−0,011	−0,093	−4429	0,000***	
Diameter of the wrist	0,013	0105	3338	0,001**	
HDL-c	−0,005	−0,054	−2746	0,006**	
Análisis de variancia					
Effect	Soma squares	GL	Half square	F	P
Regression	691,105	7	98,729	256,217	0,000***
Residual	306,342	795	0,385		
Total	997,447	802			

prevalent in men than in women. Our work highlights the high prevalence of metabolic syndrome and other CVRF in the population studied. The correlation of cardiovascular risk factors with the metabolic syndrome differs from one another, being triglycerides, glycaemia and SBP the ones with the highest predictive value. This should favor the implantation by the health institutions of preventive measures and control of cardiovascular risk factors, to improve morbidity and mortality due to cardiovascular diseases in North Alentejo.

Conflicts of interest

The authors declares that there is no conflict of interest regarding the publication of this paper.

References

[1] Ford SE, Giles WH, Dietz WH. Prevalence of the metabolic syndrome among US adults. Findings from the third national health and nutrition examination survey. J Am Med Assoc january 16 2002;287(3):356–9.
[2] Hunt KJ, Resendez RG, Williams K, Haffner SM, Stern MP. National Cholesterol Education Program versus word health organization metabolic syndrome in relation to all cause and cardiovascular mortality in the San Antonio heart study. Circulation 2004;110:1251–7.
[3] Park So-J, Kang Hee-T, Nam C-Mo, Park B-J, Linton JA, Lee Y-J. Sex differences in the relationship between socioeconomic status and metabolic syndrome: the Korean National Health and Nutrition Examination Survey. Diabetes Res Clin Pract 2012;96(3):400–6.
[4] Grundy MS. Controversy in clinical endocrinology. Metabolic Syndrome: a multiplex cardiovascular risk factor. The journal of clinical&Metabolism. 92(2): 399-404.
[5] Fiuza M, Cortez-Dias N, Martins S, Belo A. Metabolic syndrome in Portugal: prevalence and implications for cardiovascular risk -results from the VALSIM study. Rev Port Cardiol 2008;27(no12):1495–529.