ARTIGO ORIGINAL

Metabolic Syndrome in Portugal: Prevalence and Associated Factors

Síndrome Metabólica em Portugal: Prevalência e Fatores Associados

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Acta Med Port 2022 Sep;35(9):633-643 ▪ https://doi.org/10.20344/amp.15051

ABSTRACT

Introduction: The metabolic syndrome consists of a set of factors that, when associated, are associated with a higher risk of developing cardiovascular diseases and type 2 diabetes, and is thus an important public health problem. The objective of this study was to estimate the prevalence of this syndrome in the Portuguese population, and to evaluate possible associations with demographic and socioeconomic determinants.

Material and Methods: Based on the 1st National Health Survey with Physical Examination of 2015, a cross-sectional epidemiological study was conducted on a representative sample of the Portuguese population (n = 4797) aged between 25 and 74 years old. The prevalence was estimated for the total population and each gender, stratified by age group, health region, type of urban area, marital status, education, professional status, and risk of poverty. The magnitude of the associations was measured with adjusted prevalence ratios.

Results: In the Portuguese population the estimated prevalence was 33.4% [95% CI, 31.7 – 35.1] [35.6% in men (95% CI, 31.9 – 39.2) and 31.3% in women (95% CI, 28.5 – 34.2)]. In both genders, the highest prevalence was significantly associated with increasing age, widowed/married/de facto partners and those with lower levels of education. There was no association with gender, health region, type of urban area, professional status or risk of poverty.

Conclusion: Metabolic syndrome was independently associated with specific groups. This knowledge reinforces the importance of a holistic assessment of the health determinants associated with the metabolic syndrome.

Keywords: Metabolic Syndrome/epidemiology; Portugal; Prevalence

RESUMO

Introdução: A síndrome metabólica consiste num conjunto de fatores que, quando associados, conferem maior risco de desenvolver doenças cardiovasculares e diabetes tipo 2, constituindo um importante problema de saúde pública. O objetivo deste estudo foi estimar a prevalência desta síndrome na população portuguesa, e avaliar possíveis associações com determinantes demográficos e socioeconómicos.

Material e Métodos: Com base no primeiro Inquérito Nacional de Saúde com Exame Físico de 2015, realizou-se um estudo epidemiológico transversal numa amostra representativa da população portuguesa (n = 4797) entre os 25 e 74 anos. A prevalência foi estimada na população total e em cada sexo, estratificada por grupo etário, região de saúde, tipologia de área urbana, estado civil, escolaridade, situação profissional e risco de pobreza. A magnitude das associações foi medida pelas razões de prevalências ajustadas.

Resultados: A prevalência estimada foi de 33,4% (IC 95%, 31,7 – 35,1) na população portuguesa [35,6% nos homens (IC 95%, 31,9 – 39,2) e 31,3% nas mulheres (IC 95%, 28,5 – 34,2)]. Em ambos os sexos, a maior prevalência estava significativamente associada ao aumento da idade, a indivíduos viúvos/casados/unidos de facto e com menor escolaridade. Não se verificou associação com sexo, região de saúde, tipologia de área urbana, situação profissional ou risco de pobreza.

Conclusão: A síndrome metabólica estava independentemente associada a grupos específicos. Este conhecimento reforça a importância de uma avaliação holística dos determinantes de saúde associados à síndrome metabólica.

Palavras-chave: Portugal; Prevalência; Síndrome Metabólica/epidemiologia

INTRODUCTION

A significant prevalence rate of metabolic syndrome (MetS) has been found worldwide, currently representing a relevant public health issue due to its morbidity and mortality.[1] Its presence doubles the potential risk of cardiovascular disease within the following 5-10 years and is associated with a five-fold increase in the risk of type-2 diabetes when compared to patients with no MetS.[2]

Different criteria have been considered for the definition of MetS by different organisations. However, a consensus was established in 2009 between several international societies; according to this definition, MetS consists of a cluster of at least three of the following components: hyperglycaemia, arterial hypertension (HTN), hypertriglyceridaemia, low high-density lipoprotein cholesterol (HDL-C) and increased waist circumference.[2]

MetS is frequently found, showing an increasing prevalence worldwide, mostly due to the increasing prevalence of obesity and sedentary lifestyle.[2-4] A 20-25% global prevalence rate has been estimated.[5-7] A 43.1% prevalence rate (39.8% in male and 45.7% in female) has been found in the Portuguese Metabolic Syndrome (PORMETS) study, carried out in 2007/2009 in the population aged 18 or older living in mainland Portugal, using the harmonised definition.[8] The Epidemiological Study of the Prevalence of Metabolic

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Recebido/*Received*: 06/10/2020 - **Aceite/*Accepted***: 16/04/2021 - **Publicado *Online*/*Published Online***: 06/10/2021 - **Publicado/*Published***: 01/09/2022

Syndrome in the Portuguese Population (VALSIM), carried out in 2006/2007, involved patients aged 18 or older attending primary health care (PHC) in mainland Portugal and the islands and, applying similar criteria to the harmonised definition, an estimated 27.5% prevalence rate (26.0% in male and 28.7% in female) has been found.[9] On the other hand, in 2015, according to the 1st National Health Survey with Physical Examination (INSEF), the prevalence of obesity or overweight in Portugal corresponded to around two thirds of the adult population (67.6%).[10]

An increased prevalence rate of MetS has been found by a recent meta-analysis in patients with socioeconomic vulnerability [OR 1.15 (95% CI, 1.12 - 1.18)].[11] Demographic and socioeconomic determinants have been addressed by different studies, consistently showing an increased prevalence of MetS in older age groups,[7-9] with lower education[12-14] and unfavourable economic and working conditions.[15]

This study was aimed at assessing the 2015 prevalence rate of MetS and associated factors in the Portuguese population aged 25-74, considering that the most recent Portuguese estimates correspond to 2007/2009.[8]

MATERIAL AND METHODS

Data source

This was a descriptive cross-sectional observational epidemiological study with an analytical component based on the 2015 INSEF,[16] which was developed between 2013 and 2016 by the *Instituto Nacional de Saúde Doutor Ricardo Jorge* (INSA) in collaboration with the five regional healthcare administrations in mainland Portugal, the regional secretariats of health and social affairs of the autonomous regions of the Azores and Madeira and the Norwegian Institute of Public Health. All procedures were carried out according to the recommendations of the European Health Examination Survey (EHES).[17] The INSEF included three components: physical examination, blood tests and an interview based on a general healthcare questionnaire. The fieldwork was carried out between February and December 2015, by professionals specifically trained for the INSEF (117 healthcare professionals). The physical examination (measurement of blood pressure, height, weight and waist and hip circumference) was carried out by nurses and followed all the EHES procedures and recommendations. Blood pressure was measured three times on the right arm after a five-minute rest in a sitting position, with a one-minute interval between measurements. Non-fasting blood tests were obtained [lipid profile, glycated haemoglobin (HbA1c) and blood count] by medical laboratory technicians or nurses throughout the day. The questionnaire was based on standardised and widespread instruments and was applied by Computer-Assisted Personal Interview and 23 sections were included (regarding sociodemographic and socioeconomic characteristics, health, and healthcare determinants).

Study population

Non-institutionalised, Portuguese-speaking patients aged 25-74, living in Portugal in 2015 for at least 12 months prior to the date of the interview were included as target population of the INSEF. These were selected in two stages, using probabilistic sampling stratified by region (Northern, Central, Lisbon and Tagus Valley, Alentejo, Algarve, Madeira and Azores) and residential typology (rural and urban). Within the first stage, seven primary sampling units (PSU) were randomly selected in each region, generally defined as geographical areas corresponding to the catchment areas of the former National Health Service healthcare centres, with a probability of selection which was proportional to the size of the resident population of eligible age. In the second stage, individuals were selected by simple random sampling in each primary sampling unit, which made up the secondary sampling units, from the National Health Service patient's lists. The sample size was established in such a way that it was possible to estimate a 50 per cent expected prevalence, with an absolute precision of 5 per cent for a 95 per cent confidence interval, within each healthcare region in Mainland Portugal or within each Autonomous Region, considering a sample design effect of 1.5. The calculation of the minimum sample size required corresponded to 600 patients at a regional level and 4,200 nationwide, with the final sample obtained from INSEF corresponding to 4,911 individuals.[18]

The participants whose missing answers did not allow the presence or absence of MetS to be determined were excluded from the study (n = 114), corresponding to a final sample of 4,797 patients.

Study variables

Demographic and socio-economic characteristics included gender, age group (25 - 44; 45 - 54; 55 - 64; 65 - 74), region of residence (Northern, Central, Lisbon and Tagus Valley, Alentejo, Algarve, Autonomous Region of Madeira and Autonomous Region of the Azores), residential typology (rural and urban), marital status (single; married or in a civil partnership; divorced; widowed); education (illiterate/ basic education – 1st cycle; basic education - 2nd/3rd cycle; secondary education; higher education), occupational status and at-risk-of-poverty rate. The catchment areas of the PSUs were analysed using information from the 2011 Census and the typology of urban areas (TIPAU). A PSU was classified as urban when the weight of the resident population of eligible age in the parishes with a TIPAU classification of predominantly urban area was greater than 50% of the PSU's total population; otherwise, the PSU was classified as rural. Occupational status was classified into three categories – gainful employment, unemployed and non-gainful employment (including pensioners, housewives and students). The risk of poverty was assessed with the question: "Are you living in a household unable to face an unexpected expense of around 434 euros without needing to get a loan?". This item uses a percentage of the minimum wage and is part of the material deprivation items used for the assessment of the at-risk-of-poverty rate in the total population from the European Union Statistics on Income and Living Conditions (EU-SILC) 2014 - 2015.[19]

The physical examination variables included waist circumference (cm) and systolic and diastolic blood pressure (mmHg).

The study variables related to blood tests included triglyceride levels (mg/dL), HDL-C (mg/dL) and HbA1c (%).

The presence of MetS was considered whenever patients presented with at least three of the following five components: increased waist circumference (male ≥ 94 cm; female ≥ 80 cm), triglyceride level ≥ 175 mg/dL, low HDL-C levels (male < 40 mg/dL; female < 50 mg/dL), hypertension (systolic ≥ 130 mmHg, diastolic ≥ 85 mmHg or antihypertensive therapy) and HbA1c level ≥ 5.7% or oral diabetes medications. As fasting was not considered in the study, a cut-off ≥ 175 mg/dL (instead of ≥ 150 mg/dL, as described in the harmonised definition) was used for triglyceride levels. The HDL-C level was not corrected in the study, as it is not affected by fasting status.[20] Triglyceride levels and HDL-C variables did not take medication into account, as this information was omitted from the general health questionnaire. 'Fasting glycaemia ≥ 100 mg/dL' has replaced the level of HbA1c included in the harmonised definition, with ≥ 5.7% as cut-off.

Statistical analysis

There is a consensus on the gender differences in terms of health status and health-related behaviours. These differences may be due to biological aspects or behavioural determinants.[21,22] Given the multifactorial aetiology of MetS, the analysis of gender stratified estimates was more appropriate.

The study population was characterised according to demographic, socioeconomic, analytical, and physical examination variables. Frequency distribution tables were created with counts and rates for nominal and ordinal variables, while measures of central tendency (mean and median) and measures of dispersion (standard deviation, range) were used for numerical variables.

The prevalence of MetS and 95% confidence intervals (95% CI) were estimated for the total population and separately for each gender, stratified by age group, healthcare region, residential typology, marital status, education, occupational status, and risk of poverty. The Rao-Scott version of the chi-square test adjusted for the sample design was used for the comparison of the estimated prevalence rates between the categories of stratification variables.[23]

Crude prevalence ratios (PR) were estimated according to age group, healthcare region, residential typology, marital status, education, occupational status, and risk of poverty, using Poisson regression. Adjusted prevalence ratios with 95% CI [APR (95% CI)] were also estimated: in total population, prevalence ratios were adjusted for gender and age group; in each gender, these were adjusted for the age group; 'work' and 'risk of poverty' variables were also adjusted for the level of education. The Poisson regression model was selected due to the expected high prevalence of MetS (> 10%), while the use of odds ratio (OR) obtained through logistic regression could lead to an overestimation of the magnitudes of association.[24] A 5% significance level was considered.

All the point estimates were adjusted using sample weights calibrated to the distribution of the Portuguese population, by gender and age group, within each of the seven healthcare regions, for the estimate of the resident population in 2014.

The statistical analysis was carried out using R software (version 1.1.463)[25] and the survey module (version 3.36)[26] for the analysis of complex samples.

Ethical issues

This study was based on the INSEF database, which was developed following a protocol approved by the National Data Protection Commission and the Health Ethics Committees of INSA, the Regional Healthcare Administrations of the Northern, Central, Lisbon and Tagus Valley, Alentejo and Algarve regions, the Healthcare Service of the Autonomous Region of Madeira, *Hospital da Horta* and *Centro Hospitalar de Lisboa Ocidental*. A declaration of informed consent regarding physical examination, blood sampling and health interview was obtained from all INSEF participants.

The study was approved by INSA's Health Ethics Committee.

RESULTS

Characterisation of the study sample

A total of 4,797 patients (52.1% female) were included in the study (Table 1), mostly aged under 55 (64.6%), married or in a civil partnership (70.1%), living in an urban area (71.5%), with a gainful employment (61.0%) and were living in a household able to face an unexpected expense (60.9%). Around a third of the participants had completed the 2nd or 3rd cycle of basic education (32.7%) and only 17.3% had attended or completed higher education.

Blood pressure and anthropometric measurements of our group of patients, according to the relevant criteria for the definition of MetS, are shown in Table 2. In the total sample, increased waist circumference was the most prevalent component (64.5%) and low HDL-C level was the least frequent (24.2%). The distribution of the different variables varied between genders, with the greatest differences found in hypertriglyceridaemia (37.2% in male *vs.* 20.9% in female) and hypertension (58.2% in male *vs.* 41.4% in female).

In our group of patients, increased waist circumference was the most prevalent component (95.4%), followed by hypertriglyceridaemia (84.5%), low HDL-C level (62.1%) and hypertension (61.8%), while increased HbA1c was the least frequent component (50.4%). The presence of criteria for MetS (presence of at least three of the components) was found in more than half of the patients (58.1%), while 10.4% presented with all the components.

Table 1 – Demographic and socio-economic characteristics of a group of Portuguese patients aged 25-74 (n = 4,797), stratified by gender (2015)

Variable	Values	Total n	Total %	Female n	Female %	Male n	Male %	*p*-value *
Gender	Female	2,571	53.6	2,571	100.0	-	-	-
	Male	2,226	46.4	-	-	2,226	100.0	-
Age group	25 - 44	1,830	42.3	997	38.8	833	37.4	**< 0.001**
	45 - 54	1,161	22.3	633	24.6	528	23.7	**0.002**
	55 - 64	1,067	19.9	562	21.9	505	22.7	0.081
	65 - 75	739	15.5	379	14.7	360	16.2	0.485
Region	Northern	772	16.1	438	17.0	334	15.0	**< 0.001**
	Central	695	14.5	358	13.9	337	15.1	0.426
	Lisbon and the Tagus Valley	614	12.8	327	12.7	287	12.9	0.106
	Alentejo	660	13.8	350	13.6	310	13.9	0.120
	Algarve	635	13.2	324	12.6	311	14.0	0.606
	Autonomous Region of Madeira	688	14.3	373	14.5	315	14.2	**0.027**
	Autonomous Region of Azores	733	15.3	401	15.6	332	14.9	**< 0.001**
Residential typology	Rural	1,368	28.5	735	28.6	633	28.4	**0.006**
	Urban	3,429	71.5	1,836	71.4	1,593	17.6	**< 0.001**
Marital status	Single	800	16.7	385	15.0	415	18.6	0.289
	Married or *de facto* partnership	3,365	70.1	1,749	68.0	1,616	72.6	**0.022**
	Divorced	396	8.3	235	9.1	161	7.2	**< 0.001**
	Widowed	236	4.9	202	7.9	34	1.5	**< 0.001**
Education	Illiteracy / Basic (1st cycle)	1,458	30.4	760	29.6	698	31.4	0.104
	Basic (2nd / 3rd cycle)	1,568	32.7	773	30.1	795	35.7	0.578
	Secondary	939	19.6	502	19.5	437	19.6	**0.034**
	Higher	829	17.3	533	20.8	296	13.3	**< 0.001**
Occupational status	Employee	2,925	61.0	1,501	58.4	1,424	64.0	0.154
	Unemployed	536	11.2	298	11.6	238	10.7	**0.010**
	Other occupational status	1,334	27.8	770	30.0	564	25.3	**< 0.001**
Poverty risk	Inability to face unexpected expenses	1,853	39.1	1,103	43.5	750	34.0	**< 0.001**
	Ability to face unexpected expenses	2,886	60.9	1,433	56.5	1,453	66.0	0.710

* Comparison between genders

Prevalence of metabolic syndrome

A 33.4% estimated prevalence rate of MetS has been found in our group of patients (95% CI, 31.7 - 35.1) (Table 3), for the population aged 25-74. There were no statistically significant differences between genders, showing a 35.6% (95% CI, 31.9 - 39.2) estimated prevalence rate in male and 31.3% (95% CI, 28.5 - 34.2) in female patients. There was a gradual increase in prevalence from younger to older age groups [14.5% *vs.* 59.8%; PR = 4.13 (3.51 - 4.90), $p < 0.001$], and the opposite was found regarding education, with a higher prevalence in illiterate patients/basic education, and a lower prevalence in patients with higher education [55.1% vs 16.5%, PR = 3.34 (95% CI, 2.80 - 3.99), $p < 0.001$].

There were no statistically significant differences between healthcare regions or residential typology in the total population. As regards marital status, single patients showed a lower prevalence of MetS when compared to widowers [15.1% *vs.* 52.3%; PR = 3.46 (95% CI, 2.79 - 4.30), $p < 0.001$]. A lower rate of patients presenting with MetS has been found in those engaged in a gainful employment compared to those not engaged [24.5% *vs.* 54.2%; PR = 2.22 (95% CI, 1.03 - 2.54), $p < 0.001$]; higher prevalence rates have been found in patients describing not being able to face an unexpected expense [37.4% *vs.* 31.3%, PR = 1.19 (95% CI, 1.04 - 1.37), $p = 0.016$].

The trends that were found in the total population remained unchanged in the stratification by gender, with a higher prevalence of MetS found in older patients, lower education, widowers and those not engaged in a gainful employment. A higher prevalence was only found in female patients among those unable to face an unexpected expense [36.1% *vs*. 28.0%; PR = 1.29 (95% CI, 1.10 - 1.51), $p = 0.003$].

Multivariate regression model

The highest APR was found in the 65-74 age group, when compared to the 25 - 44 age group, [4.15 (95% CI, 3.51 - 4.91), $p < 0.001$], and the difference was more significant in female patients [6.94 (95% CI, 5.23 - 9.22), $p < 0.001$] than in male [2.71 (95% CI, 2.31 - 2.19), $p < 0.001$]. A statistically significant difference was also found in the association between MetS and lower education, with higher PR found in illiterate/basic education patients [1.76 (95% CI, 1.46 - 2.11), $p < 0.001$], compared to those with higher education. As regards marital status, considering single patients as a reference, APR was higher in widowed female patients [1.31 (95% CI, 1.06 - 1.62), $p = 0.018$] and in male patients who were married or who were cohabiting [1.76 (95% CI, 1.24 - 2.50), $p = 0.004$]. No statistically significant differences were found between 'gender', 'healthcare region', 'residential typology', 'work' and 'risk of poverty' variables.

DISCUSSION

The 33.4% prevalence rate of MetS found in this study was between those found in other studies. A lower prevalence (27.5%) was found in the VALSIM study[9], potentially related to the participation of patients attending primary care and with tests obtained within the previous 12 months, with a possible selection bias towards individuals with greater attention to their health status and better access to healthcare.

Table 2 – Clinical tests, blood pressure and anthropometric measurements of the group of Portuguese patients aged 25-74 (n = 4,797), stratified by gender (2015)

Variable	Total n = 4,797	Female n = 2,571	Male n = 2,226	*p*-value *
Waist circumference (cm)				
Mean	92.8	89.3	96.9	
Standard deviation	13.4	13.1	12.6	
Median	92.1	88.6	96.1	**< 0.001**
Range	57.5 - 194.0	57.5 - 148.0	66.0 - 194.0	
Increased (♀ ≥ 80 cm; ♂ ≥ 94 cm) (%)	64.5	74.4	57.4	
Systolic (mmHg)				
Mean	125.8	121.4	130.9	
Standard deviation	16.7	16.5	15.4	
Median	124.0	119.0	129.0	**< 0.001**
Range	87.5 - 224.0	87.5 - 216.0	88.5 - 224.0	
Diastolic (mmHg)				
Mean	74.2	72.4	76.3	
Standard deviation	9.9	9.4	10.1	
Median	73.5	71.5	75.5	**< 0.001**
Range	43.5 - 128.0	43.5 - 119.0	47.0 - 128.0	
Standard deviation (≥ 130/85 mmHg) (%)	49.2	41.4	58.2	
Triglyceride levels (mg/dL)				
Mean	150.7	131.9	172.4	
Standard deviation	99.9	76.5	117.7	
Median	126.0	114.0	144	**< 0.001**
Range	17.0 - 1680.0	25.0 - 885.0	17.0 - 1680.0	
Increase level (≥ 175 mg/dL) (%)	28.5	20.9	37.2	
HDL-C level (mg/dL)				
Mean	54.4	58.7	49.25	
Standard deviation	14.5	13.9	13.6	
Median	53.0	57.0	47.0	**< 0.001**
Range	17.0 - 171.0	23.0 - 130.0	17.0 - 171.0	
Low level (♀ < 50 mg/dL; ♂ < 40 mg/dL) (%)	24.2	26.7	21.2	
HbA1c test (%)				
Mean	5.5	5.4	5.6	
Standard deviation	0.8	0.7	0.9	
Median	5.4	5.3	5.4	**< 0.001**
Range	3.7 - 14.1	4.0 - 12.8	3.7 - 14.1	
Increased (HbA1c ≥ 5.7%) (%)	27.4	26.0	29.1	

c-HDL: high-density lipoprotein; HbA1c: A1c glycated haemoglobin; 95% CI: 95% confidence interval
* Comparison between genders

Table 3 – Prevalence of metabolic syndrome and 95% confidence intervals (95% CI), by demographic and socio-economic characteristics, stratified by gender and weighted for the Portuguese population aged 25-74 (2015)

Variable	Total			Female			Male		
	MetS (%)	95% CI	*p*-value	MetS (%)	95% CI	*p*-value	MetS (%)	95% CI	*p*-value
Total	**33.4**	31.7 - 35.1	-	**31.3**	28.5 - 34.2	-	**35.6**	31.9 - 39.2	-
Gender									
Female	**31.3**	28.5 - 34.2	0.140	-	-	-	-	-	-
Male	**35.6**	31.9 - 39.2		-	-	-	-	-	-
Age group									
25 - 44	**14.5**	12.3 - 16.6	**< 0.001**	**9.3**	6.7 - 11.9	**< 0.001**	**19.9**	16.2 - 23.7	**< 0.001**
45 - 54	**32.7**	28.5 - 36.9		**28.1**	21.6 - 34.5		**37.6**	29.2 - 49.0	
55 - 64	**53.8**	48.3 - 59.2		**54.2**	48.5 - 60.0		**53.2**	45.9 - 60.6	
65 - 74	**59.8**	55.3 - 64.2		**64.5**	56.3 - 72.6		**54.1**	48.3 - 59.9	
Region									
Northern	**34.2**	35.5 - 36.0	0.207	**34.0**	23.4 - 38.6	0.263	**34.5**	27.8 - 41.3	0.578
Central	**37.4**	30.6 - 44.1		**34.1**	26.5 - 41.7		**40.9**	33.5 - 48.4	
Lisbon and the Tagus Valley	**31.1**	28.4 - 33.8		**28.3**	22.8 - 33.7		**34.1**	27.1 - 41.1	
Alentejo	**34.3**	27.6 - 41.0		**30.0**	23.7 - 36.3		**38.6**	27.6 - 49.5	
Algarve	**31.1**	25.9 - 36.2		**25.9**	18.5 - 33.3		**36.5**	31.0 - 42.0	
Autonomous Region of Madeira	**28.6**	23.3 - 33.9		**28.1**	22.7 - 33.4		**29.3**	22.9 - 35.6	
Autonomous Region of Azores	**32.2**	27.8 - 36.7		**29.6**	25.8 - 33.4		**34.9**	25.9 - 44.0	
Residential typology									
Rural	**36.6**	31.4 - 41.7	0.068	**36.3**	27.3 - 45.4	0.099	**36.8**	25.9 - 47.8	0.731
Urban	**32.2**	30.7 - 33.6		**29.6**	27.2 - 31.9		**35.1**	32.0 - 38.3	
Marital status									
Single	**15.1**	12.5 - 17.7	**< 0.001**	**13.6**	8.8 - 16.5	**< 0.001**	**16.4**	10.2 - 22.6	**< 0.001**
Married or *de facto* partnership	**38.1**	36.3 - 40.0		**34.7**	31.4 - 38.0		**41.8**	37.4 - 46.3	
Divorced	**26.9**	20.5 - 33.3		**23.1**	12.5 - 33.6		**31.1**	24.0 - 38.2	
Widowed	**52.3**	41.1 - 63-6		**52.7**	41.9 - 63.5		**50.8**	25.3 - 76.3	
Education									
Illiterate / Basic (1st cycle)	**55.1**	51.9 - 58.3	**< 0.001**	**58.4**	52.7 - 64.2	**< 0.001**	**51.2**	46.6 - 55.9	**< 0.001**
Basic (2nd / 3rd cycle)	**30.2**	26.6 - 33.9		**27.6**	20.9 - 34.2		**32.4**	25.8 - 39.1	
Secundary	**25.8**	22.2 - 29.3		**18.5**	13.8 - 23.2		**33.3**	28.1 - 38.6	
Higher	**16.5**	13.6 - 19.4		**14.0**	9.1 - 19.0		**20.4**	13.2 - 27.7	
Occupational status									
Employee	**24.5**	22.3 - 26.6	**< 0.001**	**18.5**	15.1 - 21.9	**< 0.001**	**30.3**	25.4 - 35.1	**< 0.001**
Unemployed	**33.9**	28.4 - 39.4		**29.2**	20.8 - 37.6		**39.5**	32.6 - 46.3	
Other occupational status	**54.2**	50.1 - 58.3		**57.9**	52.4 - 63.4		**49.0**	43.4 - 54.7	
Poverty risk									
Inability to face unexpected	**37.4**	33.4 - 41.4	**0.018**	**36.1**	30.7 - 41.6	**0.005**	**39.2**	32.9 - 45.5	0.237
Ability to face unexpected	**31.3**	29.2 - 33.4		**28.0**	25.7 - 30.3		**34.4**	29.7 - 39.1	

95% CI: 95% confidence interval; MetS: metabolic syndrome

In addition, higher cut-off points for waist circumference and fasting glycaemia levels were used in this study. A higher rate (43.1%) of MetS according to the harmonised definition was found in the PORMETS study[8], which seems to be mainly due to the inclusion of participants aged over 74, in whom the prevalence of MetS is higher. Internationally, other studies have found similar prevalence rates in Spain[3] (31%) and the United States of America[13] (34%).

Increased waist circumference and hypertension were the most frequently found components in patients presenting with MetS, in line with the findings of international studies carried out by the Metabolic Syndrome and Arteries Research (MARE) consortium[7] and the Monica Risk, Genetics, Archiving and Monograph (MORGAM) project.[27]

Table 4 – Gross and adjusted prevalence ratio of metabolic syndrome, stratified by gender and 95% confidence intervals, weighted for the Portuguese population aged 25-74 (2015) (Table 4: part 1 of 2)

Variable	Total				Female				Male			
	PR (95% CI)	*p*-value	APR † (95% CI)	*p*-value	PR (95% CI)	*p*-value	APR ‡ (95% CI)	*p*-value	PR (95% CI)	*p*-value	APR ‡ (95% CI)	*p*-value
Gender												
Female *	ref	-	ref	-	-	-	-	-	-	-	-	-
Male	**1.14** (0.96 - 1.34)	0.138	**1.16** (1.01 - 1.33)	0.050	-	-	-	-	-	-	-	-
Age group												
25 - 44 *	ref	-	ref	-	ref	-	ref	-	ref	-	ref	-
45 - 54	**2.26** (1.91 - 2.67)	**< 0.001**	**2.26** (1.92 - 2.67)	**< 0.001**	**3.02** (2.44 - 3.74)	**< 0.001**	**3.02** (2.44 - 3.74)	**< 0.001**	**1.89** (1.42 - 2.51)	**< 0.001**	**1.89** (1.42 - 2.51)	**< 0.001**
55 - 64	**3.72** (3.11 - 4.44)	**< 0.001**	**3.72** (3.12 - 4.43)	**< 0.001**	**5.84** (4.13 - 8.26)	**< 0.001**	**5.84** (4.13 - 8.26)	**< 0.001**	**2.67** (2.19 - 3.25)	**< 0.001**	**2.67** (2.19 - 3.25)	**< 0.001**
65 - 74	**4.13** (3.48 - 4.91)	**< 0.001**	**4.15** (3.51 - 4.91)	**< 0.001**	**6.94** (5.23 - 9.22)	**< 0.001**	**6.94** (5.23 - 9.22)	**< 0.001**	**2.71** (2.31 - 3.19)	**< 0.001**	**2.71** (2.31 - 3.19)	**< 0.001**
Region												
Northern	**0.92** (0.74 - 1.13)	0.425	**0.95** (0.75 - 1.20)	0.650	**1.00** (0.74 - 1.34)	0.984	**1.04** (0.80 - 1.36)	0.754	**0.84** (0.62 - 1.14)	0.277	**0.86** (0.64 - 1.16)	0.333
Central *	ref	-	ref	-	ref	-	ref	-	ref	-	ref	-
Lisbon and the Tagus Valley	**0.83** (0.67 - 1.03)	0.104	**0.86** (0.68 - 1.07)	0.186	**0.83** (0.62 - 1.11)	0.224	**0.86** (0.69 - 1.09)	0.222	**0.83** (0.64 - 1.08)	0.183	**0.85** (0.64 - 1.13)	0.266
Alentejo	**0.92** (0.68 - 1.24)	0.580	**0.92** (0.68 - 1.25)	0.592	**0.88** (0.62 - 1.24)]	0.476	**0.88** (0.66 - 1.18)	0.404	**0.94** (0.64 - 1.38)	0.760	**0.95** (0.64 - 1.40)	0.779
Algarve	**0.83** (0.65 - 1.06)	0.144	**0.86** (0.67 - 1.09)	0.229	**0.76** (0.54 - 1.07)	0.122	**0.80** (0.62 - 1.04)	0.109	**0.89** (0.70 - 1.13)	0.353	**0.91** (0.70 - 1.19)	0.485
Autonomous Region of Madeira	**0.77** (0.60 - 0.98)	**0.047**	**0.84** (0.65 - 1.08)	0.187	**0.82** (0.61 - 1.10)	0.203	**0.90** (0.71 - 1.13)	0.360	**0.71** (0.55 - 0.94)	**0.021**	**0.77** (0.57 - 1.04)	0.103
Autonomous Region of Azores	**0.86** (0.67 - 1.11)	0.266	**0.97** (0.76 - 1.24)	0.812	**0.87** (0.65 - 1.16)	0.348	**1.00** (0.79 - 1.26)	0.990	**0.85** (0.60 - 1.22)	0.389	**0.94** (0.66 - 1.34)	0.719
Residential typology												
Rural	**1.14** (1.00 - 1.29)	0.063	**1.11** (0.98 - 1.27)	0.113	**1.23** (0.98 - 1.55)	0.087	**1.21** (0.97 - 1.51)	0.105	**1.05** (0.80 - 1.38)	0.728	**1.03** (0.83 - 1.28)	0.770
Urban *	ref	-	ref	-	ref	-	ref	-	ref	-	ref	-
Marital status												
Single *	ref	-	ref	-	ref	-	ref	-	ref	-	ref	-
Married or *de facto* partnership	**2.53** (2.14 - 2.99)	**<0.001**	**1.50** (1.29 - 1.75)	**<0.001**	**2.55** (1.74 - 3.73)	**<0.001**	**1.33** (0.97 - 1.82)	0.089	**2.55** (1.74 - 3.72)	**<0.001**	**1.76** (1.24 - 2.50)	**0.004**
Divorced	**1.78** (1.37 - 2.32)	**<0.001**	**1.09** (0.84 - 1.42)	0.533	**1.70** (1.07 - 2.70)	**0.033**	**0.94** (0.58 - 1.51)	0.796	**1.89** (1.21 - 2.96)	**0.009**	**1.31** (0.89 - 1.93)	0.175
Widowed	**3.46** (2.79 - 4.30)	**<0.001**	**1.53** (1.21 - 1.93)	**0.001**	**3.87** (2.97 - 5.04)	**< 0.001**	**1.31** (1.06 - 1.62)	**0.018**	**3.10** (1.92 - 5.00)	**< 0.001**	**1.61** (1.00 - 2.58)	0.059

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Table 4 – Gross and adjusted prevalence ratio of metabolic syndrome, stratified by gender and 95% confidence intervals, weighted for the Portuguese population aged 25-74 (2015) (Table 4: part 2 of 2)

Variable	Total				Female				Male			
	PR (95% CI)	*p*-value	APR † (95% CI)	*p*-value	PR (95% CI)	*p*-value	APR ‡ (95% CI)	*p*-value	PR (95% CI)	*p*-value	APR ‡ (95% CI)	*p*-value
Education												
Illiterate / Basic (1st cycle)	**3.34** (2.80 - 3.99)	**<0.001**	**1.76** (1.46 - 2.11)	**< 0.001**	**4.16** (2.90 - 5.96)	**< 0.001**	**1.88** (1.38 - 2.55)	**< 0.001**	**2.51** (1.75 - 3.60)	**< 0.001**	**1.53** (1.07 - 2.18)	**0.027**
Basic (2nd / 3rd cycle)	**1.83** (1.46 - 2.31)	**<0.001**	**1.45** (1.17 - 1.78)	**0.002**	**1.96** (1.29 - 3.00)	**0.004**	**1.39** (0.96 - 2.03)	0.092	**1.59** (1.09 - 2.31)	**0.022**	**1.37** (0.97 - 1.94)	0.084
Secundary	**1.56** (1.28 - 1.91)	**<0.001**	**1.46** (1.23 - 1.74)	**< 0.001**	**1.32** (0.86 - 2.02)	0.213	**1.32** (0.89 - 1.96)	0.174	**1.63** (1.19 - 2.24)	**0.005**	**1.51** (1.12 - 2.03)	**0.011**
Higher *	ref	-	ref	-	ref	-	ref	-	ref	-	ref	-
Occupational status												
Employee *	ref	-	ref	-	ref	-	ref	-	ref	-	ref	-
Unemployed	**1.39** (1.14 - 1.68)	**0.002**	**1.12** (0.95 - 1.32)	0.175	**1.58** (1.08 - 2.31)	**0.024**	**1.24** (0.91 - 1.68)	0.191	**1.30** (1.01 - 1.68)	**0.048**	**1.08** (0.82 - 1.44)	0.591
Other occupational status	**2.22** (1.93 - 2.54)	**< 0.001**	**1.06** (0.89 - 1.25)	0.512	**3.13** (2.52 - 3.90)	**< 0.001**	**1.27** (0.98 - 1.65)	0.082	**1.62** (1.35 - 1.94)	**< 0.001**	**0.85** (0.66 - 1.09)	0.211
Poverty risk												
Inability to face unexpected expenses	**1.19** (1.04 - 1.37)	**0.016**	**1.04** (0.94 - 1.16)	0.432	**1.29** (1.10 - 1.51)	**0.003**	**1.06** (0.95 - 1.18)	0.294	**1.14** (0.92 - 1.41)	0.234	**1.03** (0.85 - 1.24)	0.792
Ability to face unexpected expenses *	ref	-	ref	-	ref	-	ref	-	ref	-	ref	-

PR: gross prevalence ratio; APR: adjusted prevalence ratio; 95% CI: 95% confidence interval
* Reference category.
† Adjusted for Gender and Age; Occupational Status and Poverty risk variables also adjusted for Education variable.
‡ Adjusted for Age; Occupational Status and Poverty risk variables also adjusted for Education variable.

In this study, a higher rate of increased waist circumference has been found, possibly due to the use of a lower cut-off point, as values beyond 94 cm in men and beyond 80 cm in women are considered by different organisations as related to an increased risk of cardiovascular diseases and type 2 diabetes.[2]

Statistically significant differences were found in bivariate analysis as regards the prevalence of MetS between ‘age group’, ‘marital status’, ‘education’ and ‘occupational status’ variables, both in total population and in both genders.

As regards the ‘risk of poverty’ variable, significant differences were only found in total population and in female patients.

Differences were only found in ‘age group’, ‘marital status’ and ‘education’ variables, upon adjustment for multivariate analysis. There were no differences in the prevalence of MetS between genders. A highly variable difference between genders was found in the countries analysed in the MARE consortium study[7], with a slightly higher overall prevalence rate of MetS in female patients (24.6% *vs.* 23.9%, $p < 0.001$). A higher prevalence rate of MetS has been found in female patients in the VALSIM and PORMETS studies, which may again be related to the fact that patients aged over 74 were not included in this study. A higher prevalence rate has been found in female patients only in >49 age group in the VALSIM and PORMETS studies, and this difference became more significant with increasing age.[9,28] This higher prevalence rate may be due to the sharp rise in blood pressure after the menopause, with a higher decline in endothelial function in women.[27] This means that MetS affects a greater proportion of male patients at an early age, exposing them to these risk factors over a longer period of time. This population should be considered in further studies, as well as an early intervention to minimise potential metabolic and cardiovascular consequences.

Considering the ‘age group’ variable, the prevalence of MetS is progressively higher as patients get older. This association cuts across all studies and is largely due to the accumulation of age-related health problems, including several of the components of MetS, namely hypertension and hyperglycaemia.

The presence of MetS has been associated with married/marital partnership status in male patients and widowed female patients. As regards general health, the literature seems to show better health outcomes in married patients when compared to unmarried (including never married, divorced and widowed).[29] As regards the specific relationship between marital status and MetS, data are scarce and both the PORMETS study[8] and another study using a sample of patients living in Porto,[30] found no differences between married and unmarried patients regarding the prevalence of MetS. In addition to marital status, there may be cultural or psychological factors involved,[31] explaining this difference between genders. Issues related to the prevalence of metabolic syndrome between genders and its lifetime evolution, as well as factors involved in the differences found between the different marital statuses, should be focused by further in-depth studies aimed at a better understanding of these issues.

A low level of education is associated with a higher prevalence of MetS, as found in this study. This effect was more significant in illiterate/basic education patients and was more relevant in female patients. The relationship between education and health is well known and has been found in several international studies on MetS;[12-14] it is mediated by factors including income, access to resources, social and psychological skills and literacy.[32,33]

Study limitations and potential biases

Due to the fact that this was a cross-section study, reverse causality bias is a possibility, as no temporal relationship has been allowed between the associations found.

The possibility of selection bias was minimised by the design of the INSEF sample, which included random selection of participants and stratification by region and residential typology, strengthening its representativeness. Although the participation rate (43.9%) was beyond the expected value and for which the INSEF was designed,[16] there may be differences between individuals who agreed to participate and those who did not. A preliminary evaluation found no significant differences between participants and non-participants regarding most of the variables analysed.[10]

The fact that fasting blood tests were a requirement for the harmonised definition of MetS, which was not considered for the participation in the INSEF, was a potential information bias. When the percentage of patients in our study meeting the criteria for the different components of MetS was compared with the PORMETS[8] and VALSIM studies,[9] the biggest differences were found in the components not affected by fasting (waist circumference, blood pressure and HDL cholesterol levels). In the assessment of triglyceride levels, similar percentages were found in the three studies (27.7% *vs.* 29.4% $_{\text{vs.}}$ 30.2%), as well as regarding the glycaemia/HbA1c component, in line with the PORMETS study (27.7% *vs.* 29.4%) and higher than the VALSIM study (19.0%). It is worth mentioning that a higher cut-off point was used in the VALSIM study for glycaemia (> 110 mg/dL) than in the harmonised definition, which may explain the lower percentage found.

As regards the assessment of triglyceride levels with no fasting, this has already been found in other studies on MetS, in which the authors have considered alternative cut-off points between 200 mg/dL[34] and 175 mg/dL,[20,35,36] or even the use of the usual cut-off point of 150 mg/dL.[37] In this study, the cut-off point of the harmonised definition (150 mg/dL) was replaced by a higher cut-off point (175 mg/dL), in order to minimise classification errors.

Blood glucose levels were not obtained in the INSEF, even though the level of HbA1c was analysed as an indicator of average blood glucose over the previous eight to 12 weeks. Despite this limitation, the current evidence does not suggest any significant misclassification regarding this change in the definition of MetS. Therefore, in this study, the component of fasting glycaemia ≥ 100 mg/dL was replaced by HbA1c ≥ 5.7%. This cut-off point was based on the American Diabetes Association's definition of pre-diabetes[38] and other studies[39,40] in which fasting glycaemia ≥ 100 mg/dL and HbA1c ≥ 5.7% were considered as equivalent in terms of the risk of developing diabetes. Other studies have shown an agreement of over 90% when classifying patients presenting or not MetS according to the harmonised definition and using fasting glycaemia ≥ 100 mg/dL or HbA1c ≥ 5.7%.[41,42]

The lack of information on taking medication for hypertriglyceridaemia and low HDL-C is also a limitation of this study, which could lead to misclassification of these MetS components.

Health determinants that are relevant to metabolic syndrome were not assessed, including diet, physical activity, and smoking. Other blood parameters with a possible relationship to MetS should also have been considered, namely low-density lipoprotein cholesterol and very low-density lipoprotein cholesterol,[43] uricaemia,[44] creatininaemia[45] and sodium[46] and potassium levels.[47] The analysis of these relationships is also an important area for future studies.

CONCLUSION

MetS affects a significant percentage of the Portuguese population and is a public health issue due to the association with cardiovascular diseases and type 2 diabetes. The identification of the relationship between MetS and the patient's gender, age, group, education, and marital status is made possible with this study. In particular, the fact that MetS is more frequent in patients with lower education suggests that education, in addition to the impact on personal development and social relationships, can enhance the adoption of a healthier lifestyle with a significant impact on health. On the other hand, the associations that were found in the study add to the relevance of a holistic approach, considering other health determinants, as well as further clinical tests associated with MetS that were not assessed.

AUTHOR CONTRIBUTION

RA: Study conception and design; data analysis and interpretation; writing of the manuscript.

AJS: Contribution to data analysis and interpretation; critical revision of the manuscript.

IK: Contribution to study conception, data analysis and interpretation; revision of the manuscript.

BN: Contribution to study Conception; data analysis and interpretation.

ACF: Data interpretation; critical revision of the manuscript; approval of the submitted version.

HUMAN AND ANIMAL PROTECTION

The authors declare that this project complied with the regulations that were established by the Ethics and Clinical Research Committee, according to the 2013 update of the Helsinki Declaration of the World Medical Association.

DATA CONFIDENTIALITY

The authors declare that they have followed the protocols of their work centre on the publication of patient data.

CONFLICTS OF INTEREST

The authors declare that there were no conflicts of interest in writing this manuscript.

FINANCIAL SUPPORT

The 1st *Inquérito Nacional de Saúde com Exame Físico* (INSEF 2015), an integral part of the pre-defined *Programa Iniciativas em Saúde Pública* "Improvement of epidemiological health information to support public health decision and management in Portugal. Towards reduced inequalities, improved health, and bilateral cooperation", received a financial support of approximately 1,500,000€ from the 2009-2014 European Economic Area Financial Mechanism (*Mecanismo Financeiro do Espaço Económico Europeu*) through the EEA Grants and the Portuguese Government.

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