Anuario de Psicología
The UB Journal of Psychology | 50/2
Universitat de Barcelona

Psychological risk factors for metabolic syndrome: re-exploring the link

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Anuario de Psicología
N.º 50/2 | 2020 | págs. 66-78

Recibido: 27 de enero de 2020
Aceptado: 29 de febrero de 2020

doi: 10.1344/anpsic2020.50.6

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Abstract

This study re-explores the relationship between metabolic syndrome (MetS), according to IDF and NCEP criteria, and personality and psychopathological variables. We studied trait anger, type A behavior, type D personality, alexithymia, Zuckerman's personality dimensions, anxiety, somatization, depression, and hostility. The sample was 410 males (M_{age} = 52.54, SD = 10.43). A cross-sectional design was used with self-report data from questionnaires and biological measures. Participants completed the type D scale (DS14), the Jenkins Activity Survey (JAS), the Toronto Alexithymia Scale (TAS-20), the State-Trait Anger Expression Inventory-2 (STAXI-2), the Brief Symptom Inventory (BSI) and the shortened cross-cultural Zuckerman-Kuhlman Personality Questionnaire (ZKPQ-50-CC). The results show that subjects with IDF/NCEP criteria have significantly high scores in anxiety/negative affect, aggression-hostility, trait anger, alexithymia, negative affect, somatization, depression, and anxiety, but not in type A. No differences were found between both MetS criteria. High scores in somatization, difficulty in describing feelings, impulsive sensation seeking, and low scores in activity predict a small, but significant, part of the variance of systolic pressure, HDC cholesterol, triglycerides, glucose, and waist circumference. This study provides certain evidence for an association between MetS and psychological variables, including psychopathological symptoms, according to IDF and NCEP criteria.

Keywords

metabolic syndrome (MetS), alexithymia, type A behavior, type D personality, anxiety, depression, somatization.

Factores de riesgo psicológico en el síndrome metabólico: reexplorando la conexión

Resumen

El estudio reexplora la relación entre el síndrome metabólico (MetS), de acuerdo con los criterios IDF y el NCEP, y variables de personalidad y psicopatológicas. Estudiamos el rasgo de ira, comportamiento tipo A, personalidad tipo D, alexitimia, dimensiones de personalidad de Zuckerman, ansiedad, somatización, depresión y hostilidad. La muestra fue de 410 hombres (M_{edad} = 52,54; DE = 10,43). Se utilizó un diseño transversal con datos de autoinformes de cuestionarios y medidas biológicas. Los participantes completaron la escala de tipo D (DS14), la Encuesta de Actividad de Jenkins (JAS), la Escala de Alexitimia de Toronto (TAS-20), el Inventario de Expresión de Ira de Rasgo Estado-2 (STAXI-2), el Inventario Breve de Síntomas (BSI) y el Cuestionario de Personalidad Zuckerman-Kuhlman intercultural acortado (ZKPQ-50-CC). Los resultados muestran que los sujetos con criterios IDF/NCEP tienen puntuaciones significativamente altas en ansiedad/efecto negativo, agresividad-hostilidad, rasgo de ira, alexitimia, efecto negativo, somatización, depresión y ansiedad, pero no en el tipo A. No se encontraron diferencias entre ambos criterios de MetS. Las puntuaciones altas en la somatización, dificultad para describir los sentimientos, búsqueda de sensaciones impulsivas y puntuaciones bajas en la actividad predicen una parte pequeña, pero significativa, de la varianza de la presión sistólica, el colesterol HDC, los triglicéridos, la glucosa y la circunferencia de la cintura. El presente estudio proporciona cierta evidencia para una asociación entre MetS y variables psicológicas, incluyendo síntomas psicopatológicos, de acuerdo con los criterios de las IDF y el NCEP.

Palabras clave

Síndrome metabólico (MetS); alexitimia; comportamiento tipo A; personalidad tipo D; ansiedad; depresión; somatización.

INTRODUCTION

Metabolic syndrome (MetS) refers to a set of risk factors associated with the onset of cardiovascular disease and other health problems such as diabetes or stroke. There are different criteria or symptoms that configure definitions of MetS. The first definition was developed by the World Health Organization (WHO; Alberti & Zimmet, 1998). A year later, the European Group for the Study of Insulin Resistance (EGIR) proposed a modification to the WHO definition (Balkau & Charles, 1999). In 2005, however, two definitions were proposed which have become the current international reference for the evaluation of MetS symptoms. One of them was proposed by the International Diabetes Federation (IDF) (Zimmet, Magliano, Matsuzawa, Alberti, & Shaw, 2005), while the other was proposed by the National Cholesterol Education Program (NCEP) Adult Treatment Panel III (ATPIII) (Grundy et al., 2005).

These two organizations identify the following common criteria: 1) fasting glucose levels greater than 100 mg/Dl; 2) systolic blood pressure greater than or equal to 130 mmHg and/or diastolic blood pressure greater than or equal to 85 mmHg; 3) triglyceride levels greater than or equal to 150 mg/Dl; and 4) HDL-C levels lower than 40 mg/Dl in men and 50 mg/Dl in women. However, they differ with regard to abdominal obesity values. The NCEP criterion is that waist circumference should be greater than or equal to 102 cm in men and greater than or equal to 88 cm in women, while the IDF criterion is set at 94 cm in men and 80 cm in women. Apart from this divergence, according to the NCEP definition, metabolic syndrome will be present in people who meet three or more of the above criteria, while the IDF definition highlights the presence of obesity and two of the other criteria.

Several studies have highlighted the existence of relationships between psychological and psychopathological variables and cardiovascular risk (Goldbacher & Matthews, 2007). Friedman and Rosenman (1959) described the type A behavior pattern characterized by temporary

urgency, hostility, and competitiveness. Hostility and aggression were the traits most related to cardiovascular risk (Friedman, 1996; Lemche, Chaban, & Lemche, 2014a; Niaura, Todaro, Stroud, Spiro III, Ward, & Weiss, 2002; Todaro, Con, Niaura, Spiro III, Ward, & Roytberg, 2005; Chida & Steptoe, 2009). Aggression had causal paths to body mass index (BMI), waist circumference, and diastolic blood pressure, and hostility had causal paths to total cholesterol, triglycerides, and systolic blood pressure (Lemche et al., 2014a).

Trait anger and anger expression are also personality traits associated with the development of hypertension and stroke incident (Suls, Wang, & Costa, 1995; Everson, Kaplan, Goldberg, Lakka, Sivenius, & Salonen, 1999). In another study, in which a meta-analysis was conducted to investigate the relationship between trait anger and ambulatory blood pressure, anger was significantly and positively associated with systolic blood pressure, but not reliably associated with diastolic blood pressure (Schum, Jorgensen, Verhaeghen, Sauro, & Thibodeau, 2003). Anger is related with aggression-hostility and social risk and has a strong genetic association (García, Aluja, Fibla, Cuevas, & García, 2010).

Type D personality could be present in a greater mortality associated with coronary heart disease (CHD). Denollet (2005) developed a questionnaire to measure type D personality, called DS-14. This questionnaire includes negative affectivity (NA) and social inhibition (SI) subscales related to poor cardiac prognosis. NA refers to the tendency to experience negative emotions across time/situations, feelings of dysphoria, anxiety, and irritability. SI refers to the tendency to inhibit the expression of emotions/behaviors in social interactions to avoid disapproval by others (Denollet, 2005; Denollet, Rombouts, Gillebert, Brutsaert, Sys, & Stroobant, 1996).

Alexithymia is a personality trait that comprises impairments in the perception of bodily states, their cognitive representation, and verbal communication. It has been linked with several mental diseases and symptoms, as well as somatic illnesses, including essential hypertension, diabetes mellitus and cardiovascular risk in MetS (Lemche et al., 2014b). Karukivi, Jula, Hutri-Kähönen, Juonala, and Raitakari (2016) found that alexithymia was independently and significantly associated with hypertension. This association appears to be related to two particular dimensions of alexithymia: difficulty of describing feelings (DDF) and externally oriented thinking (EOT). Alexithymic features were also separately significantly associated with waist circumference and triglycerides as well as MetS. Alexithymic individuals with panic disorders show a cholesterol dysregulation that may be linked to suicide ideation (De Berardis et al., 2013).

A systematic review about personality as a risk factor for MetS analysed the association between personality variables and the incidence or prevalence of MetS. Personality variables were hostility, anger, type A behavior, temperament, neuroticism, and type D personality (Mommersteeg & Pouwer, 2012; Aluja & Blanch, 2007). The results described seem to indicate a greater role for negative affect/neuroticism constructs, related with type A behavior, than hostility or anxiety/ trait aggressiveness, related with type D personality, which would intervene across lifestyles. In this sense, high scores in neuroticism increase the risk of cardiovascular disease in depression (Almas, Moller, Iqbal, & Forsell, 2017). Although a recent study found an association between extraversion and the number of risk factors present in MetS, no association was found between personality traits and the presence of MetS (Ohseto et al., 2018).

Another study found that neuroticism and low agreeableness were associated with metabolic syndrome, whereas high conscientiousness was protective (Sutin, Costa, Uda, Ferrucci, Schlessinger, & Terracciano, 2010). MetS and cardiovascular disorders have been associated with anxiety and depression in many studies, especially in women (Toker, Shirom, & Melamed, 2008; Vaccarino et al., 2008; Luppino et al., 2011). In others studies this relationship has not been proven (Butnoriene, Bunevicius, Norkus, & Bunevicius, 2014; Hildrum, Mykletun, Midthjell, Ismail, & Dahl, 2009).

The aim of the current study is to re-explore the relationship between MetS, according to two sets of defining criteria (IDF and NCEP), and psychological variables, including psychopathological symptoms, in a male sample, based on the previous findings revised in the literature. The design is transversal and correlational. The reasons for including only a male sample were: a) the prevalence of metabolic syndrome is higher in men than in women, and b) there is a very important effect of sex on toxic personality and psychopathological variables. In addition, very few cases of women were available in this study. This study is exploratory and does not include formal hypotheses, but is expected to find a relationship between the psychological and biological variables related to metabolic syndrome in line with past research.

We used biological variables, such as toxic habits, biometric and biochemical measures; psychological variables, such as Zuckerman's personality dimensions (neuroticism, impulsive sensation seeking, activity, sociability and aggression-hostility), and trait anger, type A behavior, and type D personality. Psychopathological symptoms, such as anxiety, somatization, depression, and hostility, were also analyzed. Additionally, we were interested in checking the predictive power of psychological variables and psychopathological symptoms in regard to biological variables, excluding the effect of age.

METHOD

Participants and procedure

The participants were 410 Caucasian males, who were between 27 and 72 years old, with a M_{age} = 52.54 (SD = 10.43). The participants were selected from a research group heterogeneous database about cardiovascular risk. The condition was the presence/absence of MetS according to the definitions of the International Diabetes Foundation (IDF; Zimmet et al., 2005) and the National Cholesterol Education Program Adult Treatment Panel III (NCEP ATP III; Grundy et al., 2005) (Table 1). All subjects participated voluntarily and anonymously. Among the participants were 163 people who had suffered an acute coronary syndrome (myocardial infarction or unstable angina) and 247 workers who underwent a routine health check including biometric, biochemical, toxic and psychological variables. In the total sample, 57.25% (91) of the patients met the IDF criteria, and 48.48% (77) met the NCEP criteria. In contrast, only 21.54% (53) of the healthy participants met the IDF criteria, and 21.14% (52) the NCEP criteria. All participants signed a written consent form. The ethics committee of the University authorized this study. The procedures were in accordance with the Helsinki Declaration.

Biological measures

The biometric variables used were body mass index (BMI), systolic (SBP) and diastolic (DBP) blood pressure, and waist and hip circumference. The biochemical variables were cholesterol (mg/dL), high-density lipoprotein cholesterol (LDL-C, mg/dL), low-density lipoprotein cholesterol (HDL-C, mg/dL), triglycerides (mg/dL) and glucose (mg/dL). We took alcohol and tobacco as toxic variables. Alcohol consumption was determined from the average weekly consumption of beer, wine and spirits, transformed into Standard Beverage Units or SBU. One SBU is considered to be 10 grams of alcohol. For example, 1 glass of wine or champagne = 1 SBU (100 ml), 1 beer = 1 SBU (250 ml), or ½ glass of liquor = 1 SBU (25 ml). Smokers were asked how many cigarettes they smoked per day.

Psychological measures

Personality Distress Scale (DS14). The DS14 is a 14-item scale that measures the negative affectivity (NA) and the social inhibition (SI) constructs. Each sub-scale contains seven items. The answer format is a five-point Likert scale (0 = false, 4 = true). Scores of 10 or more points in both sub-scales suggest a classification in the type D personality. Alpha internal consistency of NA and SI was 0.88/0.86 in the original study (Denollet, 2005). We used the Spanish version validated by Aluja, Malas, Lucas, Worner and Bascompte (2019). In this study the DS14 obtained an alpha reliability of 0.83 (NA: 0.84 and SI: 0.78). The test-retest reliability was 0.77 for NA, 0.83 for SI, and 0.80 for the total scale. The higher and significant correlations between the DS14, NA, and SI with depression symptoms demonstrate convergent and divergent validity (Aluja et al., 2019).

Toronto Alexithymia Scale (TAS-20). The TAS-20 is a self-report instrument with 20 items rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree) (Bagby, Parker, & Taylor, 1994a, 1994b). The three factors include difficulty of identifying feelings (DIF), difficulty of describing feelings (DDF), and externally-oriented thinking (EOT). In the original study the alpha internal consistency reliability was calculated in three different categories: derivation, students, and psychiatrics. For the three samples alpha ranged between 0.64 and 0.81 (Bagby et al., 1984a). Higher scores on the scale reflect more severe alexithymia, with scores ranging

Table 1. Criteria for NCEP and IDF MetS definition

	IDF (2005)	NCEP (ATP III) (2005 revision)
Absolutely required	Central obesity (waist of circumference*): ≥94 cm (M) ≥80cm (F)	None
Criteria	Obesity, plus two of the four criteria below	Any three of the five criteria below
Obesity	Central obesity already required	Waist circumference: >40 inches (M), >35 inches (F)
Hyperglycemia	Fasting glucose ≥100 mg/dl	Fasting glucose >=100 mg/dl or Rx
Dyslipemia	TG≥150 mg/dl or Rx	TG≥150 mg/dl or Rx
Dyslipemia (second, separate criteria)	HDL cholesterol: <40 mg/dl (M), <50 mg/dl (F); or Rx	HDL cholesterol: < 40 mg/dl (M), <50 mg/dl (F), or Rx
Hypertension	>130 mmHg systolic or >85 mmHg diastolic or Rx	>130 mmHg systolic or >85mmHg diastolic or Rx

Note: *Criteria for central obesity (waist circumference) are specific for each population; values given are for European men and women. Rx pharmacological treatment.

from 20 to 100 and five reverse-scored items. We used a validated Spanish version published by Martinez-Sánchez (1996). In a previous analysis of the structure factor in accordance with the Parallel Analysis criteria (Horn, 1965), we extracted four factors. DIF and DDF factors retained the same original item structure, but EOT items were divided into two factors, one comprising items 5, 10, 18, and 19 (EOT1), and the other items 8, 15, 16, and 20 (EOT2). The two separate EOT factors resembled pragmatic thinking (PR) and lack of importance of emotions (IM), as obtained by Müller, Bühner, and Ellgring (2003). The four factors accounted for 51.57% of the total variance. Confirmatory factor analysis obtained satisfactory goodness-of-fit indices using statistics to check the dimensionality scales (Aluja, Blanch, & García, 2005; Aluja, Rolland, García, & Rossier, 2007).

Zuckerman-Kuhlman Personality Questionnaire cross-cultural shortened version. (ZKPQ-5-CC). The ZKPQ-50-CC (Aluja, Rossier, García, Angleitner, Kuhlman, & Zuckerman, 2006) is a shortened 50-item tool which has five personality scales with 10 items in each subscale: impulsive sensation seeking (ImpSS), neuroticism-anxiety (N-Anx), aggressivity-hostility (Agg-Host), activity (Act), and sociability. It consists of true/false questions. This version was developed using data from four countries: Germany, America, Switzerland, and Spain. The average alpha consistency of the five scales was higher than 0.70 in the four countries, except for Agg-Host, which had an average alpha of 0.66.

Jenkins Activity Survey (JAS). The Jenkins Activity Survey (JAS) was developed by Jenkins, Zyzanski, and Rosenman (1971) to measure type A behavior, which consists of excessive achievement striving, competitiveness, time urgency, and hostility. The JAS scale consists of 84 items that are divided in four subscales. Impatience (S), job involvement (J), and hard-driving competitiveness (H). Type A is considered an addition of the three scales. We used a Spanish validation by Fernández-Abascal (1992). The alpha reliability of type A behavior is around 0.60 in most studies.

The State-Trait Anger Expression Inventory-2 STAXI-2. The STAXI-2 is a 57-item inventory which measures the intensity of anger as an emotional state (state anger), the disposition to experience angry feelings as a personality trait (trait anger), and anger experience, expression, and control (Spielberger, 1988). The item response format consists of 4-point scales that assess both the frequency and intensity of anger at a particular moment. We only used the anger trait scales from the Spanish version (Miguel-Tobal, Casado, Cano-Vindel, & Spielberger, 2001). This scale has 10 items and is subdivided into two sub-scales of five items each: angry temperament and angry reactions. Angry temperament refers to a predisposition to experience anger and has little to do with situational factors. The angry reaction is likely to occur regardless of whether the criticism or the events were real, unintended, or imagined by the respondent. Internal consistency indexes were acceptable for state anger, trait anger and expression-control (alpha 0.89, 0.86, and 0.73, respectively).

Psychopathological symptoms

The Brief Symptom Inventory (BSI). The BSI is a short version of the SCL-R-90 (Derogatis, 1975). It comprises a 53-item self-report questionnaire and is designed to offer a screening of the symptoms of psychological disorders. The BSI contains nine symptom dimensions: somatization, obsession-compulsion, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. We used a Spanish adaptation of the BSI by Ruipérez, Ibáñez, Lorente, Moro, and Ortet (2001). Alpha reliabilities for the BSI scales showed optimal indices (between 0.70 and 0.91) in the Spanish validation study. In this research, we only used somatization, anxiety, depression, and hostility scales. All internal consistency alpha values obtained in this sample are shown in Table 3.

Data analysis

To compare the age, educational level and biological measures according to the absence/presence of both MetS diagnoses (IDF/NCEP), the U-Mann Whitney nonparametric test was performed, since the distribution of the data was not normal. A general linear model (GLM) was used to control the effect of age when comparing psychological variables in the absence/presence of MetS (in both criteria). The reason for including sick and healthy people in the IDF and NCEP criteria presence/absence classification is that many patients do not meet the MetS criteria and quite healthy subjects meet them. To predict biological measurements from psychological variables, a multiple linear regression analysis was used. In addition, Pearson correlations and partial correlations controlling for age were conducted.

RESULTS

Socio-demografic variables and prevalence of MetS

Three sociodemographic variables were reported: civil status, level of studies, and employment situation. The percentage of married people was 78.8%, 8.5% were single, 4.4% were separated, 4.4% were divorced, and 3.7% were widowed. The level of studies was evaluated in a range from 1 to 5. This was distributed as follows: 10.5% (university graduates-1), 10.1% (some university sttudies-2), 11.6% (high school-3), 24.6% (professional studies-4), and 43.3% (elementary school-5). With regard to em-

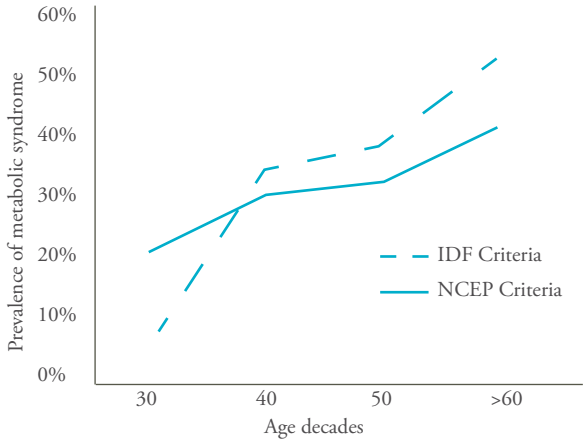
ployment, 66.1% worked for a company, 8.8% were self-employed, 14.6% were not currently working, 9.3% were retired, and 1.2% did not answer.

Figure 1 shows that the prevalence of MetS ascends with age for the two criteria used, albeit with some differences. At 30 years of age, IDF has a prevalence of 5% and NCEP of 15%, but after 40, the IDF criterion has a slightly higher prevalence. These data indicate that age is a covariate that must be controlled in the analyses in order to avoid statistical artifacts. This data can also be seen in Table 2, where age is significantly higher in both MetS criteria.

Differences in biological variables according to IDF and NCEP criteria

Table 2 shows descriptive (median and range) and non-parametric differences (Mann-Whitney U test) between subjects with absence or presence of MetS for both IDF and NCEP criteria separately. No differences were found in the level of studies and use of toxics such as tobacco and alcohol, but significant differences were found in all the biometric and biochemical variables, as expected.

Figure 1. Percentage of participants with MetS according to IDF and NCEP criteria by age.



Differences in psychological variables and MetS criteria

In order to know the relationship between psychological variables and age, a Pearson correlation was conducted.

Table 2. Non parametric comparisons for absence/presence of metabolic syndrome (MetS) according to IDF and NCEP criteria.

	IDF criteria (2005)							NCEP criteria (2005 revision)						
	Absence (n=278)		Presence (n=132)					Absence (n=287)		Presence (n=123)				
Variables	M	Range	M	Range	U-Mann Whitney	Z	*p* <	M	Range	M	Range	U-Mann Whitney	Z	*p* <
Age	50	27-70	56	32-72	11257.5	-4.36	.001	51	27-70	56	30-72	14615	-3.23	.001
Level of studies	4	1-5	4	1-5	769.5	-.04	.964	4	1-5	4	1-5	834.5	-.90	.369
Toxics														
No. cigarettes	0	0-60	0	0-50	15543.5	-.11	.910	0	0-60	0	0-50	17532	-.82	.409
Years smoking	0	0-62	0	0-55	15286.5	-.19	.846	0	0-62	0	0-55	17636	-.51	.610
Alcohol SBU	4	0-152.5	2.5	0-145	14913.5	-.63	.531	4	0-60	4	0-152.5	17564.5	-.60	.550
Biometrics														
Body Mass Index	25.79	16-5.12	28.34	16.-47.88	9831.5	-5.83	.001	26.01	16.-5.12	28.34	17.93-47.88	13097	-4.58	.001
Waist circumference (cm)	96	64-136	104.5	64-145	7244	-8.56	.001	97	64-136	105	70-145	8416	-7.04	.001
Hip circumference (cm)	100	70-170	102	70-131	11719.5	-4.00	.001	101	70-170	102	86-131	13170	-2.18	.029
Systolic BP (mmHg)	122	90-220	137	90-227	7803.5	-6.37	.001	123	90-220	138	102-227	8401.5	-7.38	.001
Diastolic BP (mmHg)	75	40-120	85	40-134	916.5	-4.82	.001	74	40-120	87	55-134	8594	-7.20	.001
Biochemical														
Cholesterol (mg/dL)	193	91-293	174	91-293	7366.5	-2.36	.019	192	91-293	167.5	75-304.5	8294	-2.81	.005
HDL-C (mg/dL)	5.5	28-104	38	28-72	4502.5	-7.09	.001	49.5	25-104	36	20-72	459.5	-8.09	.001
LDL-C (mg/dL)	115.3	35.2-204	105	35.2-203	7707	-2.09	.037	114.6	35.2-204	104.2	29-203	9111.5	-1.88	.061
Triglycerides (mg/dL)	97	38-311	164	38-531	4062.5	-7.67	.001	105	38-324	160	65-531	5316	-6.96	.001
Glucose (mg/dL)	92	70-210	105	70-263	3926.5	-7.69	.001	92	68-219	111	76-263	358.5	-9.23	.001

Note: M: median. Level of studies: 1- university graduates, 2-some university studies, 3-high school, 4-professional studies, and 5-elementary school. SBU: standard beverage units in a week. HDL-C: high-density lipoprotein cholesterol. LDL-C: low-density lipoprotein cholesterol.

ImpSS, Act, Sy and type A were significant and negatively related with age. In contrast, somatization, anxiety, DDF, EOT1 and TAS-20 were also significantly and positively related with age. Pearson and partial correlations controlling for age were conducted between psychological and IDF/NCEO criteria. Positive and significant correlations were found between N-Anx, Agg-Host, somatization, depression, anxiety, hostility, trait anger, DDF, TAS-20 and NA in IDF/NCEP MetS criteria with some difference when controlling for age.

To control the effect of age when comparing these psychological variables in the groups of absence/presence of MetS (in both criteria), a general linear model (GLM) was used. For the IDF criterion, it was found that people with metabolic syndrome had significantly higher scores in N-Anx, trait anger, negative affectivity, somatization, anxiety, hostility, DDF, and TAS-20. For the NCEP criterion, people with a MetS presence scored significantly higher in N-Anx, aggressiveness-hostility, anger, depression, anxiety, TAS-20, hostility, and somatization (Table 3). Nevertheless, in cases where the *p*-value is less than .001 the effect size was small or intermediate. Alpha internal consistency reliabilities were satisfactory except for EOT2 and type A behavior.

Linear multiple regression analysis

In order to explore the predictive power of the psychological variables (type A behavior, type D personality subscales, trait anger, alexithymia factors, BSI subscales and ZKPQ-50-CC factors) over the biological ones, a multiple linear regression analysis was carried out taking each of the biological variables as a dependent variable separately, using the input PIN criterion < 0.05 and the stepwise method. Age was included in each equation, which is the variable most related to cardiovascular risk symptoms, with the aim of calculating the net effect of the psychological variables.

We found significant equations for five regression equations: systolic BP, HDL-C, triglycerides, glucose

Table 3. Differences in psychological variables according to presence or absence of MetS controlling for age (GLM). Pearson correlation with age, and partial correlation controlling for age (IDIF and NECP)

	IDF criteria						NCEP criteria									
	Absence (n=278)		Presence (n=132)				Absence (n=287)		Presence (n=123)				Pearson and partial correlation *p* <			
	EMM	E	EMM	E	*p* <	η^2	EMM	E	EMM	E	*p* <	η^2	*Age*	IDF	NCEP	α
Neuroticism-Anxiety (ZKPQ)	2.01	.15	3.04	.21	.001	.042	2.17	.14	3.07	.21	.001	.043	.09	**.20/.21**	**.21/.18**	.75
Impulsive sen. seeking (ZKPQ)	4.11	.18	4.49	.25	.219	.003	4.16	.16	4.69	.25	.078	.032	**-.22**	-.01/.07	.04/.11	.74
Activity (ZKPQ)	5.04	.19	5.13	.27	.787	.000	5.11	.18	4.91	.27	.511	.000	**-.13**	-.03/.02	-.07/-.04	.76
Sociability (ZKPQ)	4.63	.17	4.76	.25	.658	.002	4.56	.16	5.10	.24	.061	.023	**-.15**	-.01/.03	.03/.08	.72
Aggression-hostility (ZKPQ)	3.95	.19	4.57	.26	.055	.013	3.91	.17	4.87	.26	.002	.040	.01	**.11/.11**	**.16/.16**	.75
Anger (trait) (STAXI-2)	17.45	.35	18.96	.50	.015	.017	17.69	.33	19.35	.50	.006	.038	.07	**.16/.14**	**.17/.14**	.84
DDF	16.04	.37	17.46	.53	.030	.010	16.44	.35	17.59	.53	.067	.020	**.14**	**.15/.12**	**.12**/.09	.82
DIF	10.34	.21	10.91	.30	.572	.002	10.45	.20	10.89	.30	.218	.005	.00	.07/.08	.07/.08	.71
EOT1	9.91	.20	10.11	.28	.667	.000	9.87	.18	10.36	.27	.134	.006	**.22**	.04/.03	.07/.08	.72
EOT2	10.66	.21	10.81	.29	.125	.001	10.63	.19	10.88	.29	.462	.000	.01	.06/.02	.07/.05	.68
TAS-20	46.82	.65	49.28	.93	.041	.014	47.38	.60	49.73	.92	.042	.024	**.15**	**.14/.11**	**.12/.12**	.80
Type A behavior (JAS)	181.03	5.03	189.52	7.33	.345	.003	183.38	4.71	197.15	7.35	.117	.000	**-.14**	.02/.06	.06/.09	.54
Negative Affectivity (NA)	6.51	.37	8.02	.53	.022	.017	6.87	.35	8.06	.53	.063	.021	.07	**.14/.12**	**.14**/.08	.81
Social Inhibition (SI)	9.54	.39	9.69	.55	.820	.000	9.82	.36	9.27	.55	.394	.000	.03	.02/.01	.00/-.06	.78
Type D personality (DS-14)	16.04	.64	17.71	.92	.142	.001	16.70	.60	17.32	.91	.568	.000	.06	.10/.08	.08/.06	.84
Somatization (BSI)	2.86	.24	5.06	.34	.001	.070	3.18	.23	5.22	.35	.001	.103	**.25**	**.34/.28**	**.30/.30**	.88
Depression (BSI)	2.49	.22	3.21	.31	.058	.015	2.54	.21	3.58	.32	.006	.039	.04	**.10/.10**	**.17/.16**	.76
Anxiety (BSI)	3.42	.21	4.69	.31	.001	.034	3.69	.21	4.73	.32	.007	.048	.13	**.18/.18**	**.17/.13**	.74
Hostility (BSI)	2.48	.20	3.79	.29	.001	.039	2.76	.20	3.98	.31	.001	.056	.08	**.21/.20**	**.19/.21**	.71

Note: MetS: metabolic syndrome. EMM: estimated marginal means. E: Error. η^2: partial eta squared. DDF: difficulty describing feelings. DIF: difficulty identifying feelings. EOT: externally-oriented thinking. TAS-20: Toronto Alexithymia Scale (r ≥ .11, *p* ≤ .05; r ≥ .13, *p* ≤ .01; r ≥ .15, *p* ≤ .005; r ≥ .17, *p* ≤ .001). Correlation in boldface (without/within controlling for age). α: Cronbach's alpha. $\eta 2$: .000 to.003 = *d* : .0 to.1 (no effect); . $\eta 2$: .010 to .039 = *d* : .2 to .4 (small effect); $\eta 2$: .060 to .119 = *d*: .5 to .07 (intermediate effect); $\eta 2$: .140 to .200 = *d*: .8 to ≥1 (large effect) (Cohen, 1988). For reasons of clarity, the $\eta 2$ can be transformed into Cohen *d*.

and waist circumference. In the first equation, somatization predicts 4.8% of the variance for systolic BP, 1.7% for HDL-C and 2.3% for triglycerides. The glucose level is predicted by DDF (3.8%) and ImpSS (2.7%), whereas the waist circumference is predicted by activity personality factor in negative (1.4% of the variance). In all cases, the effect of age has been discounted (Table 4).

Partial correlation between biological and psychological variables

Table 5 shows a matrix of partial correlations controlling the effect of age between the biological and psychological variables. The most significant correlations indicate that systolic BP is related to Agg-Host, somatization, anger,

Table 4. Significant linear multiple regression analysis taking biological variables as dependent and psychological as independent, including age (n= 410).

	R	R^2	Accounted variance %	Variable	Standardized beta	*t*	*p* <
Systolic (BP)	.22	.05	4.8%	Somatization	.22	4.09	.001
HDL-C	.41	.16	14.7%	Age	-.35	-5.85	.001
			1.7%	Somatization	-.14	-2.27	.024
Triglycerides	.15	.02	2.3%	Somatization	.15	2.44	.016
Glucose	.43	.19	12.2%	Age	.35	5.94	.001
			3.8%	Difficulty describing feelings	.17	2.94	.004
			2.7%	Impulsive sensation seeking	.17	2.84	.005
Waist circumference	.35	.12	10.7%	Age	.31	5.94	.001
			1.4%	Activity	-.12	-2.28	.023

Note: HDL-C: high-density lipoprotein cholesterol.

Table 5. Partial correlation between biological and psychological variables controlling for age (n=410)

	N-Anx	ImpSS	Act	Sy	Agg-Host	Somatization	Depression	Anxiety	Hostility	Anger trait	DDF	DIF	EOT1	EOT2	TAS-20	Type A	NA	SI	DS-14
Number of cigarettes	-.04	-.02	-.08	.08	.07	.03	.02	-.04	-.03	.01	.11	-.03	.13	.12	.13	.07	.06	.03	.05
Years smoking	-.02	.01	-.02	.03	.17	.03	.07	.03	.04	.10	.08	-.02	.18	.02	.11	.01	.09	.03	.07
Alcohol SBU	-.12	-.01	.04	.04	.14	.09	.08	-.02	.05	.05	-.04	-.02	.02	.06	.00	.05	.04	-.10	-.04
Body Mass Index	-.03	-.05	-.08	.11	-.01	-.08	-.08	-.12	-.08	-.14	.06	-.04	-.07	.17	-.02	-.16	-.12	-.03	-.09
Waist circumference	-.04	-.08	-.12	.10	-.06	-.01	-.05	-.07	-.08	-.10	.11	-.09	.03	.06	-.07	-.07	-.10	-.12	-.13
Hip circumference	-.03	-.05	-.03	.03	.01	.06	-.02	.07	.02	-.07	-.02	-.01	.02	.01	.00	-.08	-.05	-.03	-.05
Systolic BP	.14	.08	.01	.12	.16	.26	.12	.09	.11	.16	.09	.16	.10	.17	.19	.05	.08	.04	.07
Diastolic BP	.05	.07	.02	.16	.14	.14	.08	.08	.04	.17	.09	.06	-.01	.13	.12	.05	.09	-.04	.03
Cholesterol total	.09	.10	.05	-.05	.08	.10	.02	.10	.08	.17	-.04	-.10	-.07	-.13	-.12	.06	.19	.00	.11
HDL-C	-.04	-.05	-.01	.00	.00	-.13	-.03	.01	.00	.02	-.05	-.02	-.13	-.08	-.10	.05	.06	.00	.04
LDL-C	.06	.09	.04	-.05	.11	.09	.01	.05	.05	.20	-.03	-.10	-.04	-.12	-.11	.06	.18	-.02	.09
Triglycerides	.12	.13	.06	-.08	-.03	.19	.06	.08	.05	-.01	.05	.04	.00	.04	.06	-.02	.08	.08	.10
Glucose	-.02	.19	.13	.09	.08	-.07	.02	.00	-.02	.10	.15	.09	-.04	.17	.12	.08	-.02	-.04	-.03

Note: ImpSS: impulsive sensation seeking, N-Anx: neuroticism-anxiety, Agg-host: Aggression-hostility, Act: activity, Sy: sociability. DDF: difficulty describing feelings. DIF: difficulty identifying feelings. EOT: externally-oriented thinking. TAS-20: Toronto Alexithymia Scale. NA. Negative affectivity. SI: social inhibition. HDL-C: high-density lipoprotein cholesterol, LDL-C: low-density lipoprotein cholesterol.
($r \geq .15$, $p \leq .05$; $r \geq .20$, $p \leq .01$; $r \geq .22$, $p \leq .005$; $r \geq .25$, $p \leq .001$).

DIF, EOT2 and TAS-20. Diastolic BP is related to somatization and anger. In contrast, cholesterol is significantly related to hostility and anger. Other separate significant correlations are LDL-C with negative affectivity and anger; triglycerides with somatization; glucose with ImpSS and DDF, and with EOT2.

DISCUSSION

This study provides evidence for an association between MetS and psychological and psychopathological variables according to IDF and NCEP criteria. No differences were found in toxic habits such as alcohol or tobacco consumption for absence/presence of MetS criteria or level of studies. The personality variables most related to MetS diagnosis were neuroticism/anxiety and aggressivity/hostility, trait anger, difficulty of describing feelings, and negative affectivity. In this study, however, no significant relationship was found between type A behavior pattern and MetS. Also, subjects with MetS have higher scores on the symptoms of somatization, depression, anxiety and hostility. The significant relationships found were practically the same for each criterion, with few differences. The reliability of the internal alpha consistency of the psychometric scales used was satisfactory, since all of them are above 0.70 except for type A behavior and EOT2. The low consistency of the JAS behavior pattern has been reported by other researchers, and EOT2 has only four items when dividing the EOT scale into two (Fernández-Abascal, 1992). On the other hand, the addition of the two EOT subscales obtains satisfactory reliability.

In the 1970s, type A behavior was the first psychological variable associated with an increased risk for developing CHD in Western societies (Rosenman, Jenkins, Brand, Friedman, Straus, & Wurm, 1975; Zyzanski, Jenkins, Ryan, Flessas, & Everist, 1976). However, this relationship has not always been confirmed, and in Asia no overall evidence of an association between type A behavior and CHD incidence has been found. A Japanese macro study with 86,361 men and women aged 40-69 years showed that lower levels of type A behavior (lower levels of impatience, aggressiveness and competitiveness) increase the risk of CHD incidence (Ikeda, Iso, Kawachi, Inoue, & Tsugane, 2008). A meta-analysis showed that type A behavior across all measures and prospective study designs is not a reliable predictor of CHD incidence, when the number of independent studies and number of participants in those studies are weighted (Matthews, 1988). Several large-scale prospective studies have failed to find an association between type A behavior and CHD. The population effect size for type A and CHD is not significant according to a meta-analysis by Myrtek (2001). In contrast, hostility and anger has been more consistently related to CHD in most studies.

According to the two diagnostic criteria used, patients with MetS scored significantly higher in aggression-hostility and trait anger. These results are in line with those reported by different MetS and cardiovascular studies (Elovainio et al., 2011; Cohen, Panguluri, Na, & Whooley, 2010; Boylan & Ryff, 2015; Mommersteeg & Pouwer, 2012). In addition, hostility symptoms were also strongly related with MetS.

Alexithymia is a risk factor for MetS according to International Diabetes Federation criteria (Lemche et al., 2014b). Karukivi et al. (2016) found that difficulty of describing feelings and externally oriented thinking were related with MetS. Alexithymic features were also separately significantly associated with waist circumference and triglycerides as well as MetS diagnosis. In our study, difficulty of describing feelings was also related with both MetS criteria, with a minor age effect. In addition, difficulty of describing feelings was associated with glucose. These findings are consistent with similar studies (Deary, Scorr, & Wilson, 1997). Diabetic patients reported significantly higher alexithymia scores than the normal population (Markus, Katrin, Lisa, & Bernd, 2018). In addition, alexithymia was significantly associated with hypertension and with atherosclerotic plaques (Grabe et al., 2010). Alexithymic people take less care of their state of health or lead an unhealthy lifestyle. In other words, it is possible that alexithymic people lead a lifestyle that is not very beneficial for cardiovascular health (Helmers & Mente, 1999).

Type D personality was associated with differences in unhealthy lifestyle-related to risk factors, a higher estimated risk of developing CHD, and higher incidence of previous cardiac events (Svansdottir et al., 2013). Type D personality was related to an increased prevalence of MetS and unhealthy lifestyle, and the prevalence of MetS was higher in people with type D personality (13% vs. 6%), according to Mommersteeg, Kupper and Denollet (2010). In another study, the prevalence was 44% versus 15% for the MetS group and the control group (Tziallas et al., 2011). In our study, however, only the negative affectivity type D sub-scale is related to the presence of MetS. Negative affectivity is individually related to total cholesterol and particularly to LDL-C. Nevertheless, the association between type D personality and MetS may be mediated through the enhanced prevalence of anxiety or depressive symptoms in type D personality (Tziallas et al., 2011). In our study, anxiety and depression scores were related with MetS criteria. A macro study performed in our cultural context with 401,743 people with MetS (17.2% from the population of Catalonia) concluded that depression and anxiety play a role in the poor prognosis of patients with MetS: 8.7% had depression, 16.0% anxiety and 3.8% both; 14.5% consumed antidepressants and 20.8% tranquilizers (Ortega, Aragonès, Piñol, Basora, Araujo, & Cabré, 2018). Type D personality as a risk factor for negative health outcomes (Allen, Wetherell, & Smith, 2019).

Another objective of our study was to find out the predictive value of psychological variables relative to biological variables. High scores in somatization, difficulty in describing feelings, impulsive sensation seeking and low scores in activity predict a small, but significant, part of the variance of systolic pressure, HDC cholesterol, triglycerides, glucose, and waist circumference. Excluding the significant age effect, the variance rates obtained were relatively few and less than 5%.

Our results should be interpreted taking into account certain strength and limitations. The study has been carried out on a relatively large sample of subjects considering the cost of biological determinations. Multiple psychological variables related to CHD have been studied simultaneously in a single study. As far as we know, this is the first study in which the IDF and NCEP criteria are compared with psychological variables and this is a novelty. As a limitation it may be considered that in the context of our cross-sectional study it was not possible to examine the temporal association between personality variables and MetS. Longitudinal studies should explore this issue further. In addition, information was lacking on other important lifestyle-related factors, such as diet, socioeconomic factors, and psychotropic drug use. A strength of this study is the simultaneous use of several constructs and psychological measures associated with cardiovascular diseases in previous research.

Relationships between emotional deficits and cardiovascular disease have clinical and professional implications. The alexithymia and type D personality are distinct constructs, but they are also strictly positively related to each other (Epifanio, Ingoglia, Alfano, Lo Coco, & La Grutta, 2018). Alexithymia reflects deficits in the cognitive processing and regulation of emotions and to contribute to the onset or maintenance of several medical and psychiatric disorders. Alexithymia is a negative prognostic indicator for many psychological treatments, particularly those that focus on insight, emotional awareness, and a close alliance with a therapist. Alexithymia appears to have negative health implications, either by altering physiology, prompting symptom reporting, supporting unhealthy and compulsive behaviors, or by interfering with response to some treatments. Early detection of these emotional deficits can contribute to the prevention or treatment of metabolic syndrome

Summing up, this study was designed to re-explore the relationships between MetS and psychological variables related to normal personality, anger, alexithymia, type A behavior, type D personality, anxiety, depression, and somatization in order to check its incidence in the symptoms, according to the IDF and NCEP criteria. The results indicate a moderate association of personality variables, except type A behavior, possibly mediated by an unhealthy lifestyle and the traits of anxiety and depression. Our results are in line with the findings of the studies reviewed in different cultural contexts with similar variables.

References

Alberti, K. G. & Zimmet, P. F. (1998). Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus. Provisional report of a WHO consultation. *Diabetic Medicine*, *15*(7), 539-553. doi: 10.1002/(SICI)1096-9136(199807)15:7<539: aid-dia668>3.0.CO;2-S

Alberti, K. G., Eckel, R. H., Grundy, S. M., Zimmet, P. Z., Cleeman, J. I., Donato, K. A., … & Smith Jr, S. C. (2009). Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. *Circulation*, *120*(16), 1640-1645. doi: 10.1161/circulationaha.109.192644

Alberti, K. G., Zimmet, P., & Shaw, J. (2006). The metabolic syndrome – a new worldwide definition. *The Lancet*, *366*(9491), 1059-1062. doi: 10.1016/S0140-6736(05)67402-8

Allen, S. F., Wetherell, M. A., & Smith, M. A. (2019). A one-year prospective investigation of Type D personality and self-reported physical health. *Psychology and Health*, 1-23. doi: 10.1080/08870446.2019.1568431

Almas, A., Moller, J., Iqbal, R., & Forsell, Y. (2017). Effect of neuroticism on risk of cardiovascular disease in depressed persons – a Swedish population-based cohort study. *BMC Cardiovascular Disorders*, *17*(1), 185. doi:10.1186/s12872-017-0604-4

Aluja, A., Rolland, J. P., García, L. F., & Rossier, J. (2007). Dimensionality of the Rosenberg self-esteem scale and its relationships with the three- and the five-factor personality models. *Journal of Personality Assessment. 88*(2), 246-249. doi: 10.1080/00223890701268116

Aluja, A., & Blanch, A. (2007). Comparison of impulsiveness, venturesomeness and empathy (I7) structure in English and Spanish samples: Analysis of different structural equation models. *Personality and Individual Differences*, *43*(8), 2294-2305. doi: 10.1016/j.paid.2007.07.019

Aluja, A., Blanch, A., & García, L. F. (2005). Dimensionality of the Maslach Burnout Inventory in School Teachers: A Study of Several Proposals. *European Journal of Psychological Assessment, 21*(1), 67-76. doi: 10.1027/1015-5759.21.1.67

Aluja, A., Malas, O., Lucas, I., Worner, F., & Bascompte, R. (2019). Assessment of the Type D personality distress in coronary heart disease patients and healthy subjects in Spain. *Personality and Individual Differences*, *142*, 301-309. doi: 10.1016/j.paid.2018.08.011

Bagby, R. M., Parker, J. D, & Taylor, G. J. (1994a) The twenty-item Toronto Alexithymia Scale: I. Item selection and cross-validation of the factor structure. *Journal of Psychosomatic Research*, *38*, 23-32. doi: 10.1016/0022-3999(94)90005-1

Bagby, R. M., Taylor, G. J., & Parker, J. D. (1994b). The twenty-item Toronto Alexithymia Scale: II. Convergent, discriminant, and concurrent validity. *Journal of Psychosomatic Research, 38*, 33-40. doi: 10.1016/0022-3999(94)90006-X

Balkau, B., & Charles, M. A. (1999). For the European Group for the Study of Insulin Resistance (EGIR). Comment on the provisional report from the WHO consultation. *Diabetes Medicine, 16*(5), 442-443.

Boylan, J. M., & Ryff, C. D. (2015). High anger expression exacerbates the relationship between age and metabolic syndrome. *The Journal of Gerontology. Series B, Psychological Sciences and Social Sciences*, *70*(1), 77-82. doi:10.1093/geronb/gbt092

Butnoriene, J., Bunevicius, A., Norkus, A., & Bunevicius, R. (2014). Depression but not anxiety is associated with metabolic syndrome in primary care based community sample. *Psychoneuroendocrinology*, *40*, 269-276. doi: 10.1016/j.psyneuen.2013.11.002

Chida, Y., & Steptoe, A. (2009). The association of anger and hostility with future coronary heart disease: a meta-analytic review of prospective evidence. *Journal of the American College of Cardiology*, *53*(11), 936-946. doi: 10.1016/j.jacc.2008.11.044

Cohen, B. E., Panguluri, P., Na, B., & Whooley, M. A. (2010). Psychological risk factors and the metabolic syndrome in patients with coronary heart disease: findings from the Heart and Soul Study. *Psychiatry Research*, *175*(1-2), 133-137.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum.

De Berardis, D., Campanella, D., Serroni, N., Moschetta, F. S., Di Emidio, F., Conti, C., … & Siracusano, A. (2013). Alexithymia, suicide risk and serum lipid levels among adult outpatients with panic disorder. *Comprehensive Psychiatry*, *54*(5), 517-522. doi: 10.1016/j.comppsych.2012.12.013

Deary, I. J., Scott, S., & Wilson, J. A. (1997). Neuroticism, alexithymia and medically unexplained symptoms. *Personality and Individual Differences, 22,* 551-564. doi: 10.1016/S0191-8869(96)00229-2

Denollet, J. (2005). DS14: standard assessment of negative affectivity, social inhibition, and Type D personality. *Psychosomatic Medicine*, *67*(1), 89-97. doi: 10.1097/01.psy.0000149256.81953.49

Denollet, J., Rombouts, H., Gillebert, T. C., Brutsaert, D. L., Sys, S. U., & Stroobant, N. (1996). Personality as independent predictor of long-term mortality in patients with coronary heart disease. *The Lancet*, *347*(8999), 417-421. doi: 10.1016/S0140-6736(96)90007-0

Derogatis, L. (1975). Brief Symptom Inventory (Baltimore, Clinical Psychometric Research). *Psychopathology, 27*(1-2), 14-18. doi: 10.1016/S0191-8869(96)00229-2

Elovainio, M., Merjonen, P., Pulkki-Råback, L., Kivimäki, M., Jokela, M., Mattson, N., … & Keltikangas-Järvinen, L. (2011). Hostility, metabolic syndrome, inflammation and cardiac control in young adults: The Young Finns Study. *Biological Psychology*, *87*(2), 234-240.

Epifanio, M. S., Ingoglia, S., Alfano, P., Lo Coco, G., & La Grutta, S. (2018). Type D personality and alexithymia: common characteristics of two different constructs. Implications for research and clinical practice. *Frontiers in Psychology*, *9*, 106. doi.org/10.3389/fpsyg.2018.00106

Everson, S. A., Kaplan, G. A., Goldberg, D. E., Lakka, T. A., Sivenius, J., & Salonen, J. T. (1999). Anger expression and incident stroke: prospective evidence from the Kuopio ischemic heart disease study. *Stroke*, *30*(3), 523-528. doi: 10.1161/01.STR.30.3.523

Fernández-Abascal, E. (1992): Inventario de actividad de Jenkins. Forma C. Translation and adaptation. [Jenkins Activity Survey. Form C]. Publicaciones de Psicología Aplicada. Madrid: TEA.

Friedman, M. (1996). *Type A behavior: Its diagnosis and treatment*. Springer Science & Business Media.

Friedman, M. & Rosenman, R. H. (1959). Association of specific overt behavior pattern with blood and cardiovascular findings: blood cholesterol level, blood clotting time, incidence of arcus senilis, and clinical coronary artery disease. *Journal of the American Medical Association*, *169*(12), 1286-1296. doi: 10.1001/jama.1959.03000290012005

García, L. F., Aluja, A., Fibla, J., Cuevas, L., & García, O. (2010). Incremental effect for antisocial personality disorder genetic risk combining 5-HTTLPR and 5-HTTVNTR polymorphisms. *Psychiatry Research*, *177*(1-2), 161-166. doi.10.1016/j.psychres.2008.12.018

Goldbacher, E. M. & Matthews, K. A. (2007). Are psychological characteristics related to risk of the metabolic syndrome? A review of the literature. *Annals of Behavioral Medicine*, *34*(3), 240-252. doi: 10.1007/bf02874549

Grabe, H. J., Schwahn, C., Barnow, S., Spitzer, C., John, U., Freyberger, H. J., … & Völzke, H. (2010). Alexithymia, hypertension, and subclinical atherosclerosis in the general population. *Journal of Psychosomatic Research*, *68*(2), 139-147. doi: 10.1016/j.jpsychores.2009.07.015

Grundy, S. M., Cleeman, J. I., Daniels, S. R., Donato, K. A., Eckel, R. H., Franklin, B. A., … & Spertus, J. A. (2005). Diagnosis and management of the metabolic syndrome: An American Heart Association/National Heart, Lung, and Blood Institute scientific statement. *Circulation*, *112*(17), 2735-2752. doi: 10.1161/circulationaha.105.169404

Grundy, S. M., Cleeman, J. I., Daniels, S. R., Donato, K. A., Eckel, R. H., Franklin, B. A., … & Spertus, J. A. (2005). Diagnosis and Management of the Metabolic Syndrome: An American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement: Executive Summary. *Circulation*, *112*(17), e285-e290. doi: 10.1161/circulationaha.105.169404

Grundy, S. M., Cleeman, J. I., Daniels, S. R., Donato, K. A., Eckel, R. H., Franklin, B. A., … & Spertus, J. A. (2006). Diagnosis and management of the metabolic syndrome: an American Heart Association/National Heart, Lung, and Blood Institute scientific statement. *Current Opinion in Cardiology*, *21*(1), 1-6. doi: 10.1097/01.hco.0000200416.65370.a0

Helmers, K. F. & Mente, A. (1999). Alexithymia and health behaviors in healthy male volunteers. *Journal of Psychosomatic Medicine, 47*, 635-645. doi: 10.1016/S0022-3999(99)00067-7

Hildrum, B., Mykletun, A., Midthjell, K., Ismail, K., & Dahl, A. A. (2009). No association of depression and anxiety with the metabolic syndrome: The Norwegian HUNT study. *Acta Psychiatrica Scandinavica*, *120*(1), 14-22. doi: 10.1111/j.1600-0447.2008.01315.x

Horn, J. L. 1965. A rationale and test for the number of factors in factor analysis. *Psychometrika 30,* 179-185. doi: 10.1007/BF02289447

Huang, P. L. (2009). A comprehensive definition for metabolic syndrome. *Disease Models and Mechanisms*, *2*(5-6), 231-237. doi: 10.1242/dmm.001180

Ikeda, A., Iso, H., Kawachi, I., Inoue, M., & Tsugane, S. (2008). Type A behaviour and risk of coronary heart disease: the JPHC Study. *International Journal of Epidemiology*, *37*(6), 1395-1405.

Jenkins, C. D., Zyzanski, S. J., & Rosenman, R. H. (1971). Progress toward validation of a computer-scored test for the type A coronary-prone behavior pattern. *Psychosomatic Medicine*. doi: 10.1097/00006842-197105000-00001

Karukivi, M., Jula, A., Hutri-Kähönen, N., Juonala, M., & Raitakari, O. (2016). Is alexithymia associated with metabolic syndrome? A study in a healthy adult population. *Psychiatry Research*, *236*, 58-63. doi: 10.1016/j.psychres.2015.12.034

Kassi, E., Pervanidou, P., Kaltsas, G., & Chrousos, G. (2011). Metabolic syndrome: definitions and controversies. *BMC Medicine*, *9*(1), 48. doi: 10.1186/1741-7015-9-48

Lemche, A. V., Chaban, O. S., & Lemche, E. (2014a). Aggressivity and hostility traits affect different cardiovascular risk profiles in the metabolic syndrome. *International Journal of Cardiology*, *171*(3), e76-e. doi: 10.1186/1741-7015-9-48

Lemche, A. V., Chaban, O. S., & Lemche, E. (2014b). Alexithymia as a risk factor for type 2 diabetes mellitus in the metabolic syndrome: a cross-sectional study. *Psychiatry Research*, *215*(2), 438-443. doi: 10.1016/j.psychres.2013.12.004

Luppino, F. S., van Reedt Dortland, A. K., Wardenaar, K. J., Bouvy, P. F., Giltay, E. J., Zitman, F. G., & Penninx, B. W. (2011). Symptom dimensions of depression and anxiety and the metabolic syndrome. *Psychosomatic Medicine*, *73*(3), 257-264. doi: 10.1097/PSY.0b013e31820a59c0

Markus, S., Katrin, N., Lisa, F., & Bernd, H. (2018). Alexithymia in Type I and Type II Diabetes. *Interventions Obes Diabetes. 1*(3). doi: 10.31031/IOD.2018.01.000512

Martínez Sánchez, F. (1996). Adaptación española de la escala de Alexitimia de Toronto (TAS-20). [Spanish adaptation of the Toronto Alexithymia Scale (TAS-20)]. *Clínica y Salud, 7*(1), 19-32.

Matthews, K. A. (1988). Coronary heart disease and Type A behaviors: Update on and alternative to the Booth-Kewley and Friedman (1987) quantitative review. *Psychological Bulletin, 104*(3), 373-380. http://dx.doi.org/10.1037/0033-2909.104.3.373

Miguel-Tobal, J. J., Casado, M., Cano-Vindel, A., & Spielberger, C. D. (2001). Inventario de Expresión de la Ira Estado-Rasgo STAXI-2 [State-Trait Anger Expression Inventory STAXI-2.]. Madrid: TEA.

Mommersteeg, P. M. & Pouwer, F. (2012). Personality as a risk factor for the metabolic syndrome: a systematic review. *Journal of Psychosomatic Research*, *73*(5), 326-333. doi: 10.1016/j.jpsychores.2012.08.019

Mommersteeg, P. M., Kupper, N., & Denollet, J. (2010). Type D personality is associated with increased metabolic syndrome prevalence and an unhealthy lifestyle in a cross-sectional Dutch community sample. *BMC Public Health*, *10*(1), 714.

Müller, J., Bühner, M., & Ellgring, H. (2003). Is there a reliable factorial structure in the 20-item Toronto Alexithymia Scale? A comparison of factor models in clinical and normal adult samples. *Journal of Psychosomatic Research*, *55*, 561-568. doi: 10.1016/S0022-3999(03)00033-3

Myrtek, M. (2001). Meta-analyses of prospective studies on coronary heart disease, type A personality, and hostility. *International Journal of Cardiology*, *79*(2-3), 245-2.

Niaura, R., Todaro, J. F., Stroud, L., Spiro III, A., Ward, K. D., & Weiss, S. (2002). Hostility, the metabolic syndrome, and incident coronary heart disease. *Health Psychology*, *21*(6), 588. doi: 10.1037/0278-6133.21.6.588

Ohseto, H., Ishikuro, M., Kikuya, M., Obara, T., Igarashi, Y., Takahashi, S., ... & Mizuno, S. (2018). Relationships among personality traits, metabolic syndrome, and metabolic syndrome scores: The Kakegawa cohort study. *Journal of Psychosomatic Research*, *107*, 20-25. doi: 10.1016/j.jpsychores.2018.01.013

Ortega, Y., Aragonès, E., Piñol, J. L., Basora, J., Araujo, A., & Cabré, J. J. (2018). Impact of depression and/or anxiety on the presentation of cardiovascular events in a cohort with metabolic syndrome. StreX project: Five years of follow-up. *Primary Care Diabetes*, *12*(2), 163-171.

Rosenman, R. H., Brand, R. J., Jenkins, C. D., Friedman, M., Straus, R., & Wurm, M. (1975). Coronary heart disease in the Western Collaborative Group Study: Final follow-up experience of 8 1/2 years. *Jama*, *233*(8), 872-877.

Ruipérez, M. A., Ibáñez, M. I., Lorente, E., Moro, M., & Ortet, G. (2001). Psychometric properties of the Spanish version of the BSI – Contributions to the relationship between personality and psychopathology. *European Journal of Psychological Assessment, 17*(3), 241-250. doi:10.1027//1015-5759.17.3.241

Schum, J. L., Jorgensen, R. S., Verhaeghen, P., Sauro, M., & Thibodeau, R. (2003). Trait anger, anger expression, and ambulatory blood pressure: A meta-analytic review. *Journal of Behavioral Medicine*, *26*(5), 395-415. doi: 10.1023/A:1025767900757

Spielberger, C. D. (1988). Manual for the State-Trait Anger Expression Inventory. Odessa, FL: Psychological Assessment Resources.

Suls, J., Wan, C. K., & Costa, P. T. (1995). Relationship of trait anger to resting blood pressure: A meta-analysis. *Health Psychology*, *14*(5), 444. doi: 10.1037/0278-6133.14.5.444

Sutin, A. R., Costa, P. T., Uda, M., Ferrucci, L., Schlessinger, D., & Terracciano, A. (2010). Personality and metabolic syndrome. *Age*, *32*(4), 513-519.

Svansdottir, E., Denollet, J., Thorsson, B., Gudnason, T., Halldorsdottir, S., Gudnason, V., … & Karlsson, H. D. (2013). Association of type D personality with unhealthy lifestyle, and estimated risk of coronary events in the general Icelandic population. *European Journal of Preventive Cardiology*, *20*(2), 322-330.

Todaro, J. F., Con, A., Niaura, R., Spiro III, A., Ward, K. D., & Roytberg, A. (2005). Combined effect of the metabolic syndrome and hostility on the incidence of myocardial infarction (the Normative Aging Study). *The American Journal of Cardiology*, *96*(2), 221-226. doi: 10.1016/j.amjcard.2005.03.049

Toker, S., Shirom, A., & Melamed, S. (2008). Depression and the metabolic syndrome: gender-dependent associations. *Depression and anxiety*, *25*(8), 661-669. doi: 10.1002/da.20379

Tziallas, D., Kostapanos, M. S., Skapinakis, P., Milionis, H. J., Athanasiou, T., Elisaf, M. S., & Mavreas, V. (2011). The association between Type D personality and the metabolic syndrome: a cross-sectional study in a University-based outpatient lipid clinic. *BMC Research Notes*, *4*(1), 105.

Vaccarino, V., McClure, C., Johnson, B. D., Sheps, D. S., Bittner, V., Rutledge, T., … & Parashar, S. (2008). Depression, the metabolic syndrome and cardiovascular risk. *Psychosomatic Medicine*, *70*(1), 40-48. doi: 10.1097/psy.0b013e31815c1b85

Zimmet, P., Magliano, D., Matsuzawa, Y., Alberti, G., & Shaw, J. (2005). The metabolic syndrome: a global public health problem and a new definition. *Journal of Atherosclerosis and Thrombosis.* 12, 295-300. doi: 10.5551/jat.12.295

Zyzanski, S. J., Jenkins, C. D., Ryan, T. J., Flessas, A., & Everist, M. (1976). Psychological correlates of coronary angiographic findings. *Archives of Internal Medicine*, *136*(11), 1234-1237.