Clinical Research

Awareness, Treatment and Control of the Metabolic Syndrome and its Components: A Multicentre Greek Study

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Key words: **Metabolic syndrome: components, awareness, treatment, control.**

Introduction: There are no data concerning the degree of awareness, treatment and control of the metabolic syndrome (MetS) and its components or associated vascular risk in the general population.

Methods: A cross-sectional analysis was made of a representative sample of Greek adults (n=9,669, 49% men and 51% women), living in urban, semi-urban and rural areas (55%, 23% and 22%, respectively). The National Cholesterol Education Program (NCEP-ATP III) and the International Diabetes Federation (IDF) definitions for the MetS were used.

Results: The age-standardised prevalence of the MetS in the general population was 24.5% [95% CI 23.4-25.7%] (n=2,369). This was similar in men and women and increased with age. Among subjects with the NCEP MetS the prevalence of hypertension was 71%, elevated blood glucose 55%, low high-density lipoprotein cholesterol 58%, high triglycerides 63% and abdominal obesity 82%. Only one third of subjects were aware of the MetS component conditions, less than one quarter were on treatment, and very few (≤10%) were controlled for MetS components. Awareness of MetS individual component conditions (e.g. arterial hypertension), and consequently effective control, was lower than that reported in other cohorts, including subjects without MetS. Only 5% of subjects were aware of MetS as an entity, 2% were treated for all component conditions and only 1% were controlled. Using the IDF definition, the prevalence of MetS was higher (43.4%) and awareness, treatment and control of MetS and its components were significantly lower.

Conclusions: The prevalence of MetS is high in Greece but is not recognised among the general population. Therefore, treatment and control of MetS and component conditions are extremely low. If the situation does not improve soon, MetS will cause a further increase in the vascular disease epidemic in the years to come. This calls for urgent education of the public and the medical community.

Manuscript received: September 9, 2005;
Accepted: October 27, 2005.

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One of the achievements of contemporary healthcare is the decrease in morbidity and mortality through the control of modifiable vascular risk factors. The clustering of risk factors called the metabolic syndrome (MetS) confers an increased risk of vascular morbidity and mortality[1-7] and all-cause mortality,[2] even in the absence of clinically evident vascular disease and/or diabetes mellitus (DM).[2,3] The National Cholesterol Educational Program (NCEP) Adult Treatment Panel III (ATP

III)[8] definition of the MetS is relatively recent (2001). Therefore, there are no data on the level of awareness, treatment and control of this syndrome and its components among noninstitutionalised civilians. It is essential for both physicians and potential patients to be aware of the MetS in order to recognise and treat it effectively.

In the present population-based, cross-sectional study, we investigated the prevalence, awareness, treatment and control of the MetS and its components in a Mediterranean country (Greece).

Study design and methods

The study was carried out during 2003 and 2004 in Greece. Fifty-seven investigators, from six hospitals, 39 health care centres and the Working Groups for the Identification and Treatment of the MetS of the Greek Atherosclerosis Society and the Greek Society of General Practitioners participated in the study. The study received ethical approval and informed consent was obtained from all subjects before enrolment.

Definition of the MetS

Participants having three or more of the following criteria (according to the NCEP ATP III report[8]), were defined as having MetS:

- Abdominal obesity: waist circumference (WC) >102 cm in men and >88 cm in women;
- Hypertriglyceridaemia: fasting triglycerides ≥1.7 mmol/l (150 mg/dl) or treatment;
- Low high-density lipoprotein cholesterol (HDL-C): <1.0 mmol/l (40 mg/dl) in men and <1.3 mmol/l (50 mg/dl) in women or treatment;
- Raised blood pressure: ≥130/85 mm Hg or use of antihypertensive medication;
- Raised fasting plasma venous glucose: ≥6.1 mmol/l (110 mg/dl) or treatment.

A new definition proposed by the International Diabetes Federation (IDF)[9] and adopted by the European Association for the Study of Diabetes (EASD) and the European Atherosclerosis Society (EAS) is also available. The IDF retained 3 of the 5 NCEP ATP III diagnostic criteria. These are for hypertension, hypertriglyceridaemia and low HDL-C levels. However, the IDF set new thresholds for the remaining 2 diagnostic criteria. These are abdominal obesity (waist circumference >94 cm for Europid men and >80 cm for Europid women) and fasting plasma glucose (>5.6 mmol/l, 100 mg/dl) as suggested by the American Diabetes Association.[10] A diagnosis of MetS using the IDF criteria requires abdominal obesity + any 2 of the other 4 criteria.

Study design - study cohort

The protocol of this on-going study has been described elsewhere.[11,12] Briefly, this is a cross-sectional analysis of a representative sample of Greek adults (9,669 participants older than 18 years). All subjects were Caucasian men and women, living in urban, semi-urban, and rural areas.

Laboratory-based assessment

After an overnight 12h fast, total cholesterol, HDL-C, TGs, transaminases and glucose were measured as previously described.[11,12]

Statistical analysis

The analysis was carried out with using the SPSS 11.01 software package (SPSS, Inc., Chicago, IL). The prevalence of MetS and 95% confidence intervals (CI) were assessed using the SPSS frequency and explore procedures. Normal distribution of variables was tested with the Kolmogorov-Smirnov method. The distribution was normal and unpaired Student's t-tests and chi square tests were used for group comparisons. Mean and standard deviation (SD) of the numerical variables are reported. A two-tailed p value <0.05 was considered significant.

Results

Prevalence of MetS and component conditions

A total of 9,669 subjects, mean age 46 ± 18 years, were included in the final analysis; their characteristics are shown in Table 1. Forty-nine percent were men and 51% women, all were Caucasians; 55% lived in an urban area, 23% in a semi-urban area, and 22% in a rural area. These distributions are representative of the 2001 national Greek population census in terms of residence, age and sex.

The age-standardised prevalence of the MetS was 24.5% [95% CI 23.4%-25.7%] (n=2,369). This was similar in men and women (24.8% vs. 24.2%, p=0.8). The prevalence increased with age in both sexes. There was a 15-fold increase in the odds ratio for having MetS in the age group >70 years old compared with that of those 19-29 years old (p<0.0001). The mean age of sub-

Table 1. Characteristics of the general population, of subjects with NCEP MetS and those with IDF MetS.

	General population n=9,669	NCEP MetS n = 2,369	IDF MetS n = 4,169
Age (years ± 1 SD)	46 ± 18	57 ± 13 [1]	54 ± 16 [1,2]
Male sex %	49	51	50
Education (years ± 1 SD)	11 ± 6	10 ± 8	11 ± 6
Sedentary life %	78	88 [1]	85 [1]
High LDL-C %	46 (5029)	35 (829) [1]	30 (1250) [1,2]
Diabetes mellitus %	10 (968)	31 (734) [1]	19 (772) [1,2]
Central obesity (NCEP-IDF) %	37 (3578) - 48 (4643)	82 (1942) [1]	100 (4169) [1,2]
Raised glucose (NCEP-IDF) %	16 (1547) - 28 (2708)	55 (1303) [1]	59 (2460) [1,2]
Arterial hypertension %	32 (3094)	71 (1682) [1]	59 (2460) [1,2]
Raised triglycerides %	27 (2610)	63 (1492) [1]	56 (2334) [1,2]
Low HDL-C %	26 (2514)	61 (1445) [1]	57 (2376) [1,2]

Percentage of patients unless otherwise defined, absolute number of patients in parenthesis. HDL-C – high-density lipoprotein cholesterol; IDF – International Diabetes Federation; LDL-C – low-density lipoprotein cholesterol; MetS – metabolic syndrome; NCEP – National Cholesterol Education Program.
[1]$p<0.05$ vs the general population, [2]$p<0.05$ vs NCEP MetS

jects with MetS was higher than that of the general population (57 ± 13 vs. 46 ± 18, $p<0.0001$, Table 1).

Most subjects with MetS had 3 components of the syndrome (63%), 22% had 4 and 10% had all 5 components. Abdominal obesity (82%) and arterial hypertension (AH) (71%) were the most common abnormalities in both sexes (Table 1), while raised glucose was common (55%, 31% had DM and 24% had impaired fasting glucose [IFG]) (Table 1). If the new ADA threshold for IFG[10] (>5.6 mmol/l, 100 mg/dl) was applied 32% of subjects with MetS would have IFG and a total of 63% would have elevated glucose levels. The prevalence of raised triglyceride (TG) levels among subjects with the MetS was 63% and of low HDL-C 58% (Table 1).

There was no significant difference in smoking habit among the groups of the study. Using the 2001 National Census data* we estimated that about 2.5 million Greeks have MetS.

Awareness, treatment and control of MetS and component conditions

Of the subjects with NCEP MetS (n=2,369) only one third were aware of the component conditions, less than one quarter were being treated (with lifestyle advice or/and drug treatment) while very few were adequately controlled (≤10%) (Figure 1A). Only 5% of the subjects were aware of the MetS as an entity, 2% were treated for all component conditions and 1% were controlled for all features (Figure 1A). Of the subjects with IDF MetS (n=4,169) only one quarter were aware of the component conditions, less than one fifth were treated (with lifestyle advice or/and drug treatment), while very few were adequately controlled (≤7%) (Figure 1B). Only 3% of the subjects were aware of the MetS as an entity, 1% were treated for all component conditions and nearly 0.5% were controlled for all MetS features (Figure 1 B).

Discussion

The prevalence of MetS is high in Greece and this syndrome is unrecognised among the population. Therefore, treatment and control of MetS and its components are extremely low, with considerable potential for improvement. If the situation does not improve soon, MetS will cause a considerable increase in vascular disease in the future.

The data on prevalence of MetS in this paper (referring to 2003 and 2004, n=9,669) derive from all over Greece. They are similar to those derived from northern Greece (2003, n=4,153) that we have reported previously.[10]

Our results indicated an effective control of hypertension in 9% of subjects with MetS. This is lower than the national percentage and is probably due to the lower blood pressure threshold used (130/85 mmHg) to de-

(*http://www.kethi.gr/greek/statistika/Apasxolisi/APOGRAFI_01.htm), we estimated that about 2.5 million Greeks have MetS.

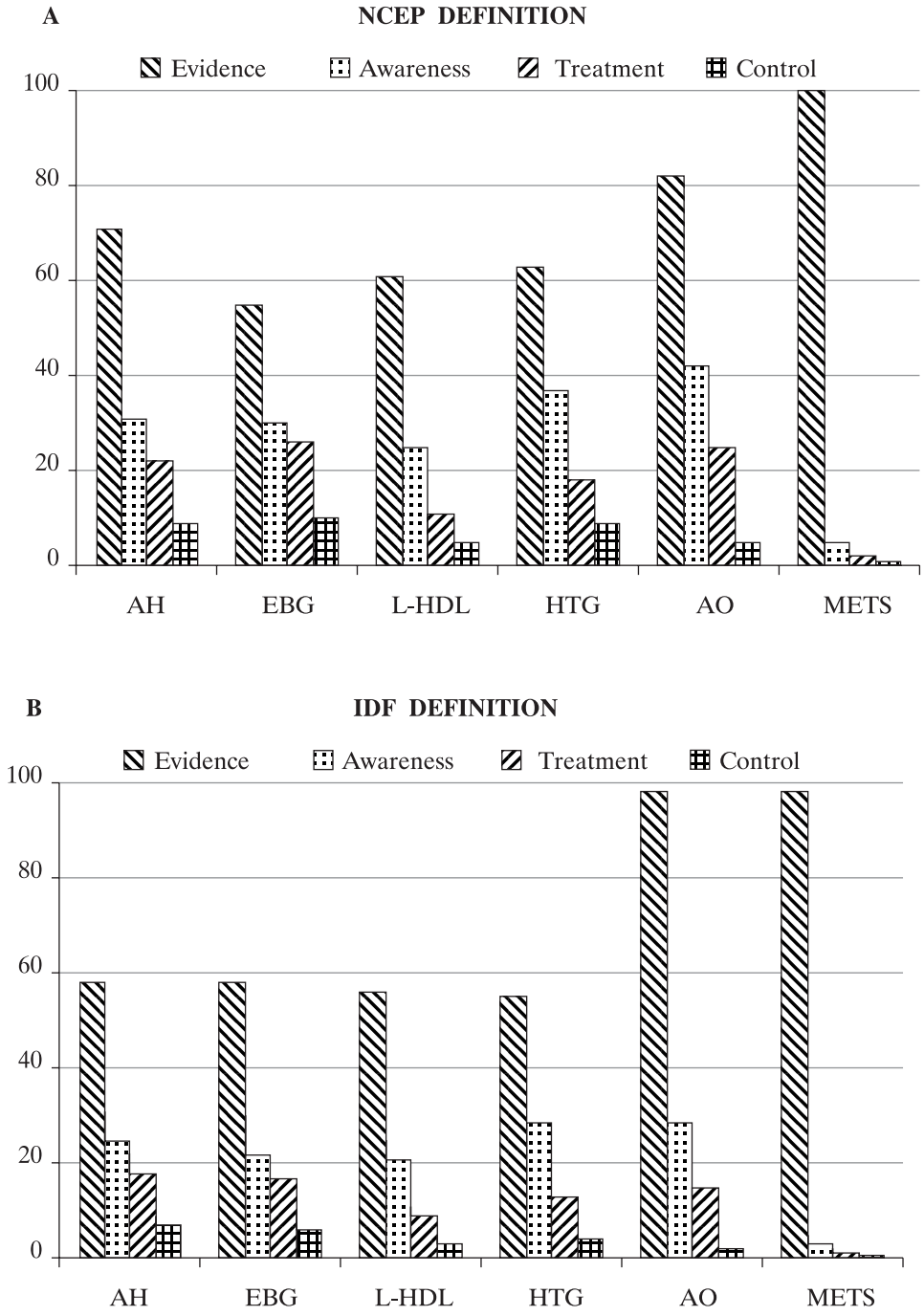

Figure 1. Prevalence, awareness, treatment and control of metabolic syndrome (MetS) and its components according to the NCEP (A) and IDF definitions (B).

AO – abdominal obesity; AH – arterial hypertension; EBG – elevated blood glucose; HTG – hypertrygliceridaemia; IDF – International Diabetes Federation; L-HDL – low high-density lipoprotein cholesterol; NCEP – National Cholesterol Education Program.

fine hypertension associated with MetS.[8] Hypertension is the most thoroughly investigated MetS component in terms of awareness, treatment and control, mainly in cohorts including subjects without MetS. At the 140/90 mmHg threshold, in the US 24% to 29%[13,14] of hypertensives, in Canada 17% and in Europe (5 European countries) <=10% have their blood pressure controlled.[14] These findings are in agreement with a meta-ana-

lysis of data from 6 European countries suggesting that on average only 8% of hypertensive individuals were adequately controlled.[15] Three studies in Greece addressed the issue of awareness, treatment, and control of hypertension using the threshold of 140/90 mmHg. From a large cohort (n=26,913 subjects), EPIC (Greek component of the European Prospective Investigation into Cancer and nutrition study)[10] reported a prevalence of hypertension of 44%; 23% of subjects were aware of their condition and 15.2% had their blood pressure effectively controlled. Similarly, the ATTICA study (n=2,282)[17] reported effective control in 15% of hypertensives. Finally, the DIDIMA Study (n=694),[18] coming from a specialised outpatient clinic managed to control hypertension in 27% of the participants. All the above suggest that limited awareness and inadequate treatment and control of hypertension is a universal phenomenon. Nevertheless, the lower threshold for both systolic and diastolic blood pressure adopted by the MetS definitions, practically unknown to the public, substantially contributes to the lower treatment rate and control of hypertension.

In the present study, the percentages of subjects with MetS and controlled low HDL-C, high TGs, were 5% and 8%, respectively. These poor results might be attributed to the fact that treatment of dyslipidaemia focuses mainly on low-density lipoprotein cholesterol (LDL-C),[19] while high TGs or low HDL-C (both diagnostic features of MetS) are often neglected. Given that in Greece even for controlling LDL-C, the primary goal of treating dyslipidaemia,[8] the results are still poor,[19] the undertreatment of high TGs and low HDL-C comes as no surprise.

Our results show that the prevalence of IFG among subjects with MetS was nearly as high as that of type 2 DM (Table 1), or even higher if the ADA 2004 definition[10] is adopted (Table 1). In a report from the US[20] the prevalence of unrecognised type 2 DM was as high as 4.5% in the general population and 61% of known diabetic patients were uncontrolled.[20,21] The prevalence of IFG in 13 European countries is 10%[22,23] and it seems that IFG is a modifiable risk factor for cardiovascular disease (CVD).[22,23] The situation is further complicated by subjects with IFG having other features of the MetS.[24] Thus, if we take into consideration that IFG is practically unknown among the general population and DM is underdiagnosed and undertreated to a significant extent,[20] then the low rates of awareness, treatment and control of disturbed glucose metabolism is to be expected. Impaired glucose metabolism (type 2 DM and IFG) might be attributed to the very high incidence of obesity (82%) in subjects with NCEP MetS. Obesity seems to be related to the change in lifestyle in Greece during the last decades.[16]

Our overall findings are surprising, because in Greece, up to a few decades ago, the majority of the population had a high level of physical activity and were on a Mediterranean diet, which reduces the probability for the development of the MetS and decreases the risk of CVD-related events.[25-27] It has been reported[25] that the prevalence of both conventional vascular risk factors and MetS components in those that adopted the Mediterranean diet are significantly lower than that of those that did not.[25] In particular, the adoption of this diet is associated with a 30% reduction in acute coronary events.[25] This nutritional pattern is evident in Crete,[28] where the traditional Mediterranean diet has been shown to confer substantial benefits.

Recent data, since the adoption of a more "western" lifestyle in Greece, suggest that total lipid consumption is high (40% of total energy intake[29]), although the ratio of mono-unsaturated to saturated dietary lipids is much higher than in other countries, including northern Europe and North America.[29] Therefore, we assume that the protective influence from MetS and CVD is not caused by single nutrients (e.g. dietary fatty acids or dietary fibre) but is attributable to the Mediterranean diet as a whole.[29-32] Moreover, data suggest that physical activity at work or during leisure time has been dramatically reduced during the last few decades (>80% of subjects included in the study lead a sedentary life). All these factors combined play a substantial role in shaping MetS prevalence, because the adoption of the Mediterranean diet by physically active people is associated with a much higher reduction in the odds of developing the MetS or a vascular event than diet or exercise achieve alone.[33] These changes in lifestyle were not followed by the education of the public and the medical community about the excessive vascular risk related to MetS. This has played a substantial role in limiting awareness, treatment and control of MetS and its components.

We recently reported[34] that effective control of MetS and its components, with strict lifestyle counselling and multitargeted drug treatment, may reduce the associated vascular risk by up to 76%, to a level not higher than that of the general population.[34] Thus, the means to reduce MetS-related morbidity and mortality are at hand and reducing this risk is achievable. The main issue is that we should focus on the identification and effective treatment of MetS. This will require the education of the general population and physicians.

Conclusions

Using the NCEP definition, awareness, treatment and control of the MetS are extremely limited, though its prevalence is high. With the IDF definition all the above are much worse, probably because more people are considered to have MetS using this definition.[35] Treatment and control of MetS and its components should be a high priority in order to avoid a vascular disease epidemic in the years to come. Education of the public and physicians is long overdue. Lifestyle changes and, if necessary, drug treatment will significantly reduce the burden of this syndrome.

Acknowledgements

We thank the Greek Atherosclerosis Society, the Greek Society of General Practitioners and the following for the collection of the data: Ahladas H (HC), Akritopoulos P (GH), Apousidou VP (GH), Arseniou A (HC), Athanasiou PI (HC), Batou ND (HC), Bouloukos VI (UH), Bourdouvalis IA (HC), Dimopoulou SP (HC), Dionisopoulou SG (GH), Georgaki AN (HC), Gazis E (UH), Giapoutsidis V (GP), Giouleme O (UH), Hartaba VG (HC), Kalaitzidou EL (GP), Karaleftheri MP (HC), Karotsis AL (GP), Kapousouzi MI (HC), Kesidou NI (HC), Kiourtzidou BL (HC), Kouroudi AI (HC), Lazaridou PG (HC), Liakou K (HC), Matsou AT (HC), Messios R (HC), Notaridis G (HC), Patroklou S (HC), Paulidou H (HC), Pehlivanidis AN (UH), Petridis DI (HC), Polychronidis E (HC), Posnahidou DN (HC), Prokopiadou D (GP), Prokopidis D (GP), Protopapas N (HC), Psaltoglou I (HC), Sarigianni M (GH), Satsoglou EA (GH), Sekeri ZP (HC), Sfakianakis M (HC), Symeonidis A (HC), Tsakiris K (HC), Tsakoundakis N (GP), Troulaki Z (HC), Tsiknaki SB (HC), Vasilopoulou D (HC). UH = University Hospital, GH = General Hospital, GP = General Practice, HC = Health Center.

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