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Metabolic Syndrome among the Inhabitants of the Island of Vis

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A B S T R A C T

Metabolic syndrome (MS) was measured on the sample of 307 inhabitants of the island of Vis. Two criteria where used, one defined by the WHO (World Health Organization) and the other defined by the NCEP (National Cholesterol Education Program). The results according to NCEP definition showed a 47.2% of prevalence of MS, which is high but expected because of high independent factors analyzed in the study. These values are the highest in Croatia and among the highest measured in the World. MS definition according to NCEP proved to be more sensitive than that of the WHO, which shoved values of 21.2%. A link between MS (NCEP) and diabetes and cardiovascular diseases was also established.

Key words: *metabolic syndrome, island of Vis, complex diseases*

Introduction

Metabolic syndrome (MS) is nowadays considered as one of the main predictors for the occurrence of some complex diseases. It contains a series of risk factors related to the occurrence of cardiovascular diseases and diabetes type II. Indications are: obesity, dyslipidemia, insulin resistance, carbohydrates intolerance and hypertension. Terms defining MS are not completely equalized in various studies and in different organizations. First it had been named »syndrome X«, but in 1998 the term metabolic syndrome was accepted by the World Health Organization (WHO), and obesity was taken as the main component for the definition of MS[1].

As already said, several criteria are internationally accepted for the diagnostics of metabolic syndrome (MS): WHO (World Health Organisation), NCEP (National Cholesterol Education Program), IDF (International Diabetes Federation), AACE (American Association of Clinical Endocrinologists) and EGIR (European Group for the Study of Insuline Resistance)[2].

The criteria of the WHO and of the NCEP are internationally most accepted. They agree on the main components of metabolic syndrome; obesity, insulin resistance, dyslipidemia and hypertension. Difference between them is first of all in clinical criteria for the cluster identification. World Health Organization (WHO) is regarded as the first organization that has defined metabolic syndrome and its criteria are held valid for research work. This definition is most liable to criticism; reasons for that lie in the fact that it is too complex for clinical and epidemiological investigations. The inclusion of the insulin resistance measure and the waist-hip ratio as the measure of relative accumulation of fat tissue are mentioned as the greatest drawbacks of this definition. The NCEP criteria are viewed as less complicated and thus more acceptable for clinical and epidemiological investigations. This opinion is based on the simpler measurements of abdominal obesity (waist circumference) and on the avoidance of the so-called »glucose centrism«, i.e. considering glucose disorders as equal to other risk factors[1,3,4].

The majority of recent studies are based on the investigations of MS, so we can single out the study by Kolčić et al., in which a high prevalence is established in island isolates. Thus, Mljet had the highest MS prevalence of 53%, while the prevalence in Komiža and Vis was 33% and 34% respectively. The same investigation has not confirmed the influence of kinship on the prevalence of MS. The high MS prevalence of 42% according to NCEP is shown in the investigation on the Island of Hvar. The results of Rudan et al. confirmed the higher incidence of

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various carcinomas in the island populations (Brač, Hvar, Korčula, Vis and Lastovo) in comparison to the control population of the coastal Dalmatia. Having in mind the identical impact of external factors upon both populations and the high coefficient of inbreeding in island populations, such results were expected[2,5].

It has been concluded that kinship itself is responsible for 36% of hypertension cases in the sample of 2760 persons from 25 settlements on the island isolates[6]. The prevalence of hypertension in the sample of 1126 persons (on Pelješac, Brač, Hvar and Korčula) was 31 (82%) in men and 28 (23%) in women[7]. As for biochemical parameters, it has been proved that isolated populations of Vis and Rab have significantly elevated values of triglycerides and HDL-cholesterol in comparison to the general Croatian population[8].

On the Island of Hvar has been observed the tendency of changes in nutritional habits among the present-day inhabitants, what includes the increased intake of meat, pasta, cakes and coffee[9].

Regarding all the mentioned, this proposed research should be the further contribution to holistic anthropological investigations of the inhabitants on one of the Adriatic isolates – the Island of Vis.

Subjects and Methods

The investigation is based on scientifically accepted research methods of anthropogenetic isolates in the Eastern Adriatic[10–12]. The choice of respondents and applied methods are performed according to the protocol of the Institute for Anthropology, Zagreb, as well as to the propositions of the International Biological Program[13].

The Island of Vis belongs to the group of Middle Dalmatian islands, under the influence of Mediterranean climate with supposed Mediterranean diet of its inhabitants. There are two towns on the island, Vis and Komiža, and several villages comprising the group of Vis Villages, situated in the island's interior.

The research comprised the sample of 307 respondents (Komiža, the Vis Town and Vis villages), consisting of 135 men and 172 women aged between 17 and 85 years. The sample was recruited from electoral rolls. The consent of each examinee was obtained before the onset of investigation. The site of the settlements on the Island of Vis (Komiža, Vis Town and Vis Villages) from where the sample was taken is shown on Figure 1.

Within the sample, Komiža is represented with 137 examinees (44.6%), Vis Town with 75 (24.4%) and Vis Villages with 95 (30.9%). The ratio of men and women is almost equal in all groups, amounting to approximately 44% to 56%. The results of the respondents distribution in groups is shown on Figure 1.

The total mean value of the examinees' life age on the whole island is 57 years (Komiža 55.7 yrs, Vis Town 58 yrs, Vis Villages 58 yrs). The samples, i.e. the particular groups of examinees do not statistically differ regarding age. The mean age of men is 56.5 years and of women

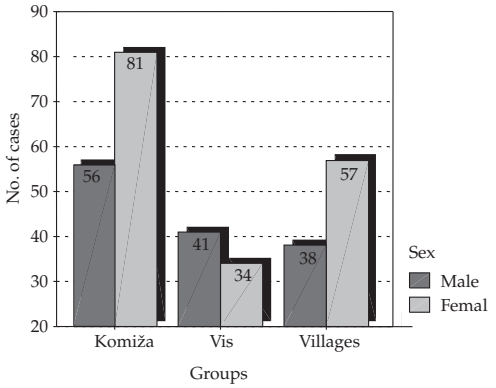

Fig. 1. The group distribution of examinees (N=307).

57.3 years, which is not a statistically significant difference. The mean values of age associated with groups and gender are graphically presented in Figure 2**,** showing that the number of examinees does not significantly differ in age cohorts either.

The complex anthropogenetic characteristics analyzed in this investigation were chosen according to International Biological Program guidelines that are worldwide accepted for the investigations with similar aims[13].

Measures were performed with the standard techniques of the Institute for Anthropology, according to the guidelines of the »Practicum of Biological Anthropology«, including »Anthropometry«[14], »Physiological Methods – 1«[15] and »Physiological methods in anthropological investigations«[16], while biochemical blood tests were done at the Polyclinic for Medical Laboratory Diagnostics »Laborcentar«, Bukovčev trg 4, 10000 Zagreb.

In the analysis were included anthropometric variables, height and weight, used for the estimation of the body mass index, as well as systolic and diastolic blood pressure. The nutritional habits of the inhabitants were obtained from the dietary habits index, implemented in the standard questionnaire for field work. The food frequency questionnaire is compiled to show how many times a week the people eat certain foods. The question-

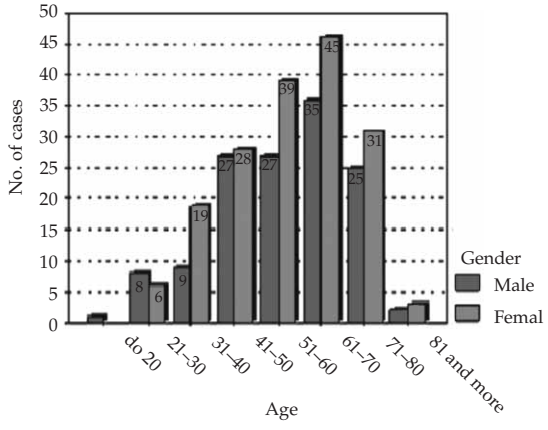

Fig. 2. The distribution of examinees associated with life age (N=307).

TABLE 1
PARAMETERS FOR THE ESTIMATION OF METABOLIC SYNDROME ESTABLISHED BY WHO

	Normal		Abnormal	
	n	(%)	n	(%)
Increased waist-hip ratio or ITM>30 kg/m^2	99	(32.2)	208	(67.8)
Glucose	235	(76.8)	71	(23.2)
Triglycerides	224	(73.2)	82	(26.8)
HDL-cholesterol	144	(47.2)	161	(52.8)
Elevated blood pressure (measured 140/90 or diagnosed)	93	(30.4)	213	(69.6)

naire also reveals the respondents' age. At the Polyclinic for Medical Laboratory Diagnostics »Laborcentar« the following blood tests were performed: creatinine, HDL, cholesterol, urate, triglycerides, LDL and glucose. Limiting values of biochemical parameters of blood and blood pressure, when calculating independent risk factors, were estimated according to the WHO and NCEP[17,18].

Results

Fisher's exact test confirmed the absence of statistically significant relation of metabolic syndrome according to WHO and gender (p=0.574).

As statistically significant predictors for metabolic syndrome according to WHO proved to be elevated blood pressure and diabetes:

1) Examinees with diagnosed or measured increased blood pressure have almost 3.7 times greater chance for having metabolic syndrome (after WHO) than examinees without diagnosed or measured elevated blood pressure.

TABLE 2
METABOLIC SYNDROME ACCORDING TO WHO

		n	(%)
Metabolic syndrome	no	242	(78.8)
	yes	65	(21.2)

2) Examinees with diabetes have 8.7 times greater risk for metabolic syndrome (after WHO) than examinees without diabetes (p<0.011).

Pearson's chi-square test established statistically significant relation of metabolic syndrome (defined by WHO) and the groups (χ^2=7.570; df=2, p=0.023): the lowest number of examinees with metabolic syndrome was found in Komiža (14.6%) and the highest in Vis Villages (29.5%).

In order to find the connection of the intake frequency of certain food stuffs and metabolic syndrome according to WHO, we conducted multiple regression analysis with metabolic syndrome as the criterion variable and certain groceries as predictors.

Before performing multiple regression, we had checked the presence of correlations (as one of the variables is

TABLE 3
METABOLIC SYNDROME ACCORDING TO WHO AND GENDER

		Gender			
		Male		Female	
		n	%	n	%
Metabolic syndrome according to WHO	no	104	(77.0)	138	(80.2)
	yes	31	(23.0)	34	(19.8)
Total		135	(100.0)	172	(100.0)

TABLE 4
METABOLIC SYNDROME ACCORDING TO WHO AND DISEASES

		Metabolic syndrome (WHO) N (%)				Total		OŠ (95% IP) p*	
		no		yes				Univariance analysis	Multivariance analysis
Elevated blood pressure (diagnosed or measured)	no	86	(92.5)	7	(7.5)	93	(100.0)	1	1
	yes	156	(73.2)	57	(26.8)	213	(100.0)	4.489 (1.961–10.273) <0.001	3.680 (1.554–8.716) 0.003
Coronary diseases	no	223	(80.2)	55	(19.8)	278	(100.0)	1	1
	yes	19	(65.5)	10	(34.5)	29	(100.0)	2.134 (0.939–4.848) 0.070	1.488 (0.585–3.783) 0.404
Brain infarction	no	233	(79.0)	62	(21.0)	259	(100.0)	1	1
	yes	9	(75.0)	3	(25.0)	12	(100.0)	1.253 (0.329–4.767) 0.741	0.732 (0.162–3.301) 0.685
Diabetes	no	234	(83.0)	48	(17.0)	282	(100.0)	1	1
	yes	8	(32.0)	17	(68.0)	25	(100.0)	10.359 (4.229–25.375) <0.001	8.691 (3.429–22.031) <0.001

TABLE 5
METABOLIC SYNDROME (DEFINED BY WHO) AND GROUPS

		Groups					
		Komiža		Vis Town		Vis Villages	
		n	%	n	%	n	%
Metabolic syndrome (defined by WHO)	no	117	(85.4)	58	(77.3)	67	(70.5)
	yes	20	(14.6)	17	(22.7)	28	(29.5)
Total		137	(100.0)	75	(100.0)	95	(100.0)

dichotomous, we here calculated the point-biserial correlation) coefficient of all predictors (intake of certain foods) with the criterion variable (metabolic syndrome) and confirmed the existence of only one statistically significant, but rather weak correlation: metabolic syndrome is negatively related to the intake of butter (r= 0.136; p=0.008).

Regression analysis was done by Stepwise method, and after one step of regression analysis as statistically

TABLE 6
PARAMETERS FOR THE ESTIMATION OF METABOLIC SYNDROME ACCORDING TO NCEP

	Normal		Abnormal	
	n	(%)	n	(%)
Waist circumference	155	(51.0)	149	(49.0)
Glucose	235	(76.8)	71	(23.2)
Triglycerides	224	(73.2)	82	(26.8)
HDL	144	(47.2)	161	(52.8)
Elevated blood pressure (measured 130/85 or diagnosed)	45	(14.7)	262	(85.3)

TABLE 7
METABOLIC SYNDROME DEFINED BY NCEP

		n	(%)
Metabolic syndrome according to NCEP	no	162	(52.8)
	yes	145	(47.2)

significant predictor showed to be precisely the consummation of butter. The coefficient of multiple determination (R^2) is 0.019, what means that the proportion of the criterion variable variance, i.e. metabolic syndrome, explained by this predictor is somewhat less than 2%, what is a very small percentage. After performing the F-test, which tested the significance of multiple regression coefficients, the value of F was 0.767 (p=0.017). That means that R, as well as R2, are significant at the risk level of 1%, i.e. that the negative relation between this predictor (intake of butter) and the criterion (metabolic syndrome according to WHO) really exists in the population.

The total number of examinees with metabolic syndrome according to the NCEP criteria was 47.2%.

Fisher's exact test confirmed the statistically significant relation of metabolic syndrome after NCEP and

TABLE 8
METABOLIC SYNDROME ACCORDING TO NCEP AND GENDER

		Gender			
		Male		Female	
		n	%	n	%
Metabolic syndrome according to NCEP	no	80	(59.3)	82	(47.7)
	yes	55	(40.7)	90	(52.3)
Total		135	(100.0)	172	(100.0)

TABLE 9
METABOLIC SYNDROME (AFTER NCEP) AND DISEASES

		Metabolic syndrome (after NCEP) N (%)				Total		OŠ (95% IP) p*	
		no		yes				Univariance analysis	Multivariance analysis
Elevated blood pressure (diagnosed or measured)	no	40	(88.9)	4	(11.1)	45	(100.0)	1	1
	yes	122	(46.6)	140	(53.4)	262	(100.0)	9.180 (3.512–23.997) <0.001	8.691 (3.264–22.616) <0.001
Coronary diseases	no	148	(53.2)	130	(46.8)	278	(100.0)	1	1
	yes	14	(48.3)	15	(51.7)	29	(100.0)	1.220 (0.567–2.623) 0.611	0.820 (0.361–1.863) 0.636
Brain infarction	no	156	(52.9)	139	(47.1)	259	(100.0)	1	1
	yes	6	(50.0)	6	(50.0)	12	(100.0)	1.122 (0.354–3.560) 0.845	0.862 (0.258–2.875) 0.879
Diabetes	no	156	(55.3)	126	(44.7)	282	(100.0)	1	1
	yes	6	(24.0)	19	(76.0)	25	(100.0)	3.921 (1.520–10.111) 0.005	3.660 (1.351–9.918) 0.011

TABLE 10
METABOLIC SYNDROME (DEFINED BY NCEP) AND GROUPS

		Groups					
		Komiža		Vis Town		Vis Villages	
		n	%	n	%	n	%
Metabolic syndrome according to NCEP	no	78	(56.9)	38	(50.7)	46	(48.4)
	yes	59	(43.1)	37	(49.3)	49	(51.6)
Total		137	(100.0)	75	(100.0)	95	(100.0)

gender (p=0.050): there are more women with metabolic syndrome after NCEP (52.3%) than men (40.7%).

As statistically significant predictors for metabolic syndrome according to WHO proved to be elevated blood pressure and diabetes:

3) examinees with diagnosed or measured increased blood pressure have almost 8.7 times greater chance for having metabolic syndrome (after NCEP) than examinees without such diagnosis (p<0.001)

4) examinees with diabetes have 3.7 time greater risk for metabolic syndrome (after NCEP) than examinees without it (p<0.011).

Pearson's χ^2-test established the absence of statistically significant relation of metabolic syndrome (defined by NCEP) and the groups (χ^2=1.807; df=2. p=0.405).

In order to find the association of the frequency of intake of certain food stuffs and metabolic syndrome according to NCEP, we conducted multiple regression analysis with metabolic syndrome as the criterion variable and certain groceries as predictors.

Before performing multiple regression, we checked the presence of correlations (here we, as one of the variable is dichotomous, calculated the point-biserial correlation coefficient) of all predictors (intake of certain foods) with the criterion variable (metabolic syndrome), but we did not confirm any statistically relevant correlation.

Discussion

The established MS on Vis of 47.2% according to NCEP is high, but expected in regard to previously analyzed independent risk factors like biochemical blood tests, the analyzed blood pressure and measures of obesity. In this study, the estimation of MS according to the NCEP criteria proved to be more sensitive than the WHO estimation. Having in mind remarkably high levels of individual factors, the NCEP estimation could more accurately describe the actual state on the island. According to numerous studies, the most risky are considered the factors of age, high blood pressure, elevated total and HDL cholesterol and diabetes, while somewhat less risk present obesity, raised triglycerides and glucose[3].

In regard to the results showing that 51.7% of the examinees with MS (defined by NCEP) have coronary disease, 50% examinees with MS (after NCEP) had a brain infarction, while 76% of those with MS (after NCEP) and 69% (according to WHO) respectively have diabetes type II, these investigation clearly confirmed the results of many international studies on the high relation of MS with the mentioned complex diseases[19–21]. The fact that 66.7% of the examinees with malignant tumors have MS as well (after NCEP) could suggest that MS is an extremely high risk factor for those complex diseases too. The causes of the high prevalence of MS on the island of Vis should be sought in the change of nutritional habits, but also in other external factors not related to diet, like smoking, stress, physical activity, etc[22–24].

The prevalence of MS according to NCEP was lower on the neighboring island of Hvar, i.e. 42% when the waist circumference was taken as the measure of obesity, but higher i.e. 26%, when ITM was calculated as the measure of obesity. This clearly shows that the waist circumference is a better predictor for MS, having the higher diagnostic sensitivity. The ratio of MS in men and women was inverted. In Hvar there were more men with MS than on Vis, where more women had MS (defined by NCEP). The study of Kolčić et al. performed on the Adriatic isolates: Rab, Mljet, Vis and Lastovo also showed the higher prevalence of MS (the NCEP version) in women (39%) than in men (28%). The highest prevalence of MS in Croatia, according to the same study, was found on the island of Mljet (53%), while the high prevalence was found on Vis (Vis Town 34%, Komiža 33%), Rab (Banjol 37%, Barbat 31%, Lopar 42%, Rab 25%, Sup. Draga 30%) and Lastovo (30%). Such prevalence is comparable to the results obtained by the research of MS on the population of Baranja, where MS regarding ITM was 40% (35% in men and 42% in women), but considering the waist-hip ratio it was 42% (52% in men and 38% in women)[5,25]. The comparison is interesting first of all due to the great difference in nutritional habits between the insular (Mediterranean) and continental Croatia. The high prevalence of MS in Baranja is more likely due to dietary habits that include high intake of saturated fats, meat and meat products, while the high prevalence on the islands should be less expected due to the supposed Mediterranean diet. We can assume that one of the causes is the change of nutritional habits on the islands, directed at the quantitatively rich but qualitatively poor diet. Such diet could also be the impetus for the expression of certain genes in such an isolated milieu. It would be interesting to compare the MS prevalence on Vis and other Croatian regions, but unfortunately we do not have enough data on the level of Croatia.

The comparison with some other Mediterranean countries is interesting because of the presupposed similar nutritional and life habits. On Sicily the established prevalence of MS according to NCEP is 22%, with gender differences (men 12.4% and women 31.5%), what is substantially below the prevalence on Vis (47.2%) following the same criteria[26]. The high prevalence of MS on Vis (the NCEP definition) is confirmed by the comparison with the prevalences in the whole of Italy (25%). Greece (24%) and Turkey, where according to the national study

(after WHO) the MS prevalence was 10.09% for men and 27.33% for women[27–29]. The highest world MS prevalence of 55% was found in the studies of Resnik et al. on the sample of 2000 American Indians. The prevalence of MS among other populations in the USA was as follows: the Americans of Mexican origin 30–32%, the Americans of European origin 20–24%, the Afro-Americans 22%[2,30–32]. Slightly higher prevalences of MS were observed in The Netherlands isolates (according to NCEP) from 23–37%, or on the Gran Canaria island with 28% (the WHO definition)[33,34]. These results clearly confirm the high prevalence of MS on Vis and other middle Dalmatian islands, particularly on the Island of Mljet. The high prevalence among the American Indians, in the Netherlands isolates and in the supposed Adriatic isolates could suggest the significant impact of genes, having in mind the evolution forces that are stronger in small and isolated populations. When a certain gene occurs in a smaller population, it has greater probability of survival and expansion. The second reason could be changed dietary habits. As already shown in the »Pima Paradox«, where the Pima Indians, but also some other tribes, had changed their dietary habits (greater intake of fast food, monosaccharides and saturated fats), the result was the epidemics of diabetes type II in younger generations in comparison to their ancestors, in whom the disease was not present to such a degree[35].

Our investigations showed the expected association of coronary diseases with MS. Thus the conclusion that 51.7% of people with coronary disease have MS as well suggests that MS presents 2.4 to 3.4 times higher risk for the occurrence of these diseases[19].

Conclusion

Relatively abrupt change of nutritional habits could be a potent trigger for the expression of genes causing the occurrence of complex diseases, what in regard to evolutional forces is more observable in the examined isolated population.

Regarding the almost alarming state related to the cited high prevalence of complex disease, it is necessary to warn and educate the islands population. Similarly, it is necessary to perform constant medical check-ups in island populations in order to monitor the increasing prevalence of the mentioned complex diseases.

Investigations have shown that the diagnosed MS is one of the highest possible risks in the occurrence of diabetes type II and cardiovascular diseases.

The NCEP method of establishing MS has shown to be more sensitive in relation to the WHO method, as in this study the established prevalences of MS were 47.2% according to NCEP and 21.2% after WHO. Regarding the significant correlation of MS determined by NCEP with diabetes and cardiovascular diseases, we can conclude that this method is better.

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METABOLIČKI SINDROM KOD STANOVNIKA OTOKA VISA

S A Ž E T A K

Metabolički sindrom (MS) istraživan je na uzorku (N=307) populacije otoka Visa. MS je procjenjivan prema dva kriterija; WHO (World Healt Organisation) i NCEP (National Cholesterol Education Programe). Utvrđeni MS prema NCEP-u od 47,2% bio je visok, no očekivan obzirom na visoke neovisne rizične čimbenike analizirane u studiji. Ovako visoki MS jedan je od najviših u Hrvatskoj, ali i u Svijetu. U ovoj studiji procjena MS prema NCEP-u pokazala se senzibilnijom u odnosu na procjenu prema WHO (21,2%). Pokazana je i značajna povezanost MS (prema NCEP-u) sa dijabetesom i kardiovaskularnim bolestima.