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# Prevalence of Increased Body Weight and Hypertension in the Population of Croatian Mainland and Adriatic Islands – Are Islanders Really Healthier?

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## ABSTRACT

*The aim of this study was to compare the prevalence of the hypertension and the increased body weight (BMI) between Croatian mainland and Adriatic island population. The data from the Croatian Adult Health Survey (N=9,070) served as an estimate for the mainland Croatian population, while the data from »1001 Dalmatian study« (N=1,001) were collected from four Adriatic islands; Rab, Vis, Lastovo and Mljet. The prevalence of increased body weight and hypertension was calculated for the four age groups and analyzed using chi-square test. The results indicate that men from the islands less frequently had normal body mass index ( $P<0.001$ ), and were more frequently overweight ( $P<0.001$ ). The prevalence of overweight and obesity were similar between the island and mainland women. The percent of normotensive respondents in men was significantly lower in islands ( $P<0.001$ ), while the prevalence of newly diagnosed hypertension was significantly higher among islanders in both genders ( $P<0.001$ ). Despite the traditionally prevalent Mediterranean diet and overall more favorable lifestyle islanders may not be as healthy as previously studies suggested, in terms of cardiovascular risk factors prevalence. This might be related to the poor access to health care and preventive measures or low interest for health care especially among men on the islands, reflected in the higher prevalence of newly diagnosed hypertension. These findings suggest that island populations represent good candidates for disease awareness programs and health promotion interventions.*

**Key words:** body mass index, hypertension prevalence, islands, mainland, Croatia

## Introduction

Isolation is among crucial elements in the creation of new species and it has often been labeled as one of the major forces in the evolutionary biology<sup>1</sup>. However, among humans the isolated populations are declining globally due to increased mobility and breakdown of the tradi-

tional village groups and urbanization<sup>2</sup> that seems to affect health<sup>3-6</sup>. Still, one type of isolated human populations that remains present in various countries is island populations<sup>7</sup>. In Croatia, a number of studies were conducted among such populations investigating their health

status and suggesting unique genetic structure of islanders<sup>8–28</sup>. Few studies of the blood pressure among island populations pointed that these populations could have higher blood pressure and higher prevalence of hypertension than the mainland<sup>14,19</sup>. In contrast, traditionally healthier lifestyle, marked by the Mediterranean diet that has beneficial effects on cardiovascular health is more prevalent on the islands<sup>29</sup>.

Island populations have higher levels of homogeneity compared to the mainland population, not only in genetic structure<sup>8</sup> and some quantitative traits<sup>30</sup>, but also in socio-economic status, such as in the case of island Vis which virtually lacks socio-economic inequalities in selected health-related indicators<sup>31</sup>, except in terms of some gender-related differences<sup>32</sup>. Additionally, as showed previously, islanders have better health-related psychological functioning, but worse social functioning which is probably attributable to the geographic isolation<sup>33</sup>.

The aim of this study was to compare the some cardiovascular risk factors, body mass index and hypertension prevalence in the Croatian mainland and island populations and provide an answer as to whether the island inhabitants are really healthier than their mainland counterparts.

## Materials and Methods

In this study we compared the data from two studies, the Croatian Adult Health Survey (CAHS) and the 1001 Dalmatian (1001D).

The CAHS is a large population based survey conducted in 2003, aiming to provide the prevalence of cardiovascular risks in the Croatian population<sup>34</sup>. The sample was defined on the household basis<sup>35</sup>, and it is considered to be representative for the adult population of Croatia. To increase its representativeness, the CAHS sample has been additionally weighted through complex, seven-step weighting scheme. Further details on the study are given elsewhere<sup>34</sup>.

The study 1001 Dalmatian is a population based genetic epidemiology study conducted in 2002–2004 in the four Croatian Adriatic islands; Rab, Vis, Lastovo and Mljet. The aim of the study was to describe the genetic structure of these populations, the prevalence of complex diseases and to map candidate genes. The study encompassed a total of 100 randomly selected individuals from nine villages on these islands; Barbat, Banjol, Rab, Lopar

and Supetarska Draga in the island of Rab, Vis and Komiza in the island of Vis, and the population from the islands of Lastovo and Mljet. Beside these nine groups, the tenth group (N=101) was defined from the immigrants in these villages who were residents of the islands for several years and were therefore considered as the island inhabitants. So far, this study described in details population genetics structure of the islands and served as a screening tool for the implementation of the larger genetic study that has yielded some interesting results<sup>36–40</sup>.

## Measures

Two cardiovascular risk factors were compared: the body mass index (BMI) and the blood pressure. According to the BMI, participants were classified in three groups, those with the normal body weight (BMI  $\leq$  24.9), the overweight (BMI from 25.0 to 29.9), and the obese one (BMI  $\geq$  30.0). To classify participants according to the blood pressure we used two parameters, measured blood pressure and medical history of hypertension, and created four groups (Table 1).

The respondents were further classified into the four age groups: 18–34, 35–49, 50–64, and those over 64 years of age. We compared the prevalence of BMI and blood pressure by age groups and all analyses were conducted on gender stratified samples.

## Statistical analysis

All analyses were based on the frequency of each category in two study samples. Weighted estimates from CAHS were used, meaning that the estimates were calculated on the basis of the entire Croatian population. Additionally, a weighting scheme was applied to island populations as well, to correspond to age and gender composition for each island, further increasing the 1001 Dalmatian sample representativeness. Chi-square test was used in the analysis (or Fisher's test, where appropriate). Analysis was made in the SAS 8.02 package, with significance set at  $P < 0.05$ .

## Results

In the aggregated samples comparison (all ages) we found that men from islands less often had normal BMI ( $\chi^2=20.0$ ,  $P=0.001$ ), and were more frequently overweight ( $\chi^2=12.0$ ,  $P<0.001$ ). There was no significant difference in the prevalence of obese respondents ( $\chi^2=1.2$ ,

**TABLE 1**  
THE BLOOD PRESSURE GROUPS DEFINED BY THE MEASURED BLOOD PRESSURE AND THE MEDICAL HISTORY INFORMATION PROVIDED BY THE RESPONDENTS

Blood pressure group	Measured blood pressure in mmHg	Medical history of hypertension
(I) Normotensive	Under 140 (systolic) and 90 (diastolic)	Negative
(II) Newly diagnosed hypertension	Over 140 or 90	Negative
(III) Improperly treated hypertension	Over 140 or 90	Positive
(IV) Properly treated hypertension	Under 140 and 90	Positive

P=0.279). After sample breakdown in four age groups, we detected that in the youngest age group there were no differences, while in the other three groups men from the islands were heavier (Table 2). In women there were no significant difference among BMI groups between mainland and islands populations in the aggregated samples ( $\chi^2=1.6$ , P=0.208,  $\chi^2=0.3$ , P=0.612, and  $\chi^2=0.9$ , P=0.337 for normal BMI, overweight and obesity, respectively). After sample breakdown, we detected that island women in the youngest age group were more frequently having a normal body mass index ( $\chi^2=9.8$ , P=0.002), were less overweight ( $\chi^2=5.5$ , P=0.019), and finally had lower prevalence of obesity (Fisher P<0.001) (Table 2). In the 35–49 age group the differences diminished for normal body mass index ( $\chi^2=2.8$ , P=0.094) and obesity ( $\chi^2=1.5$ , P=0.220), while island population had more overweight women ( $\chi^2=7.4$ , P=0.007) (Table 2).

The prevalence of normotensive respondents in men was lower in the island population ( $\chi^2=30.9$ , P<0.001), while at the same time the prevalence of newly diagnosed hypertension in islands was much higher ( $\chi^2=60.7$ , P<0.001). There was no significant difference in the

mainland vs. islands in the prevalence of improperly treated hypertension ( $\chi^2=0.4$ , P=0.520), but the prevalence of properly treated hypertension was significantly lower in the island population ( $\chi^2=11.6$ , P<0.001). Re-grouping of the EBP groups revealed that the prevalence of respondents who reported hypertension in their medical history was 23.4% in the mainland group and 20.9% in the island group, without significant difference ( $\chi^2=1.7$ , P=0.188) (Table 3).

In women there was no difference in the prevalence of normotensive respondents ( $\chi^2=2.6$ , P=0.104), while the prevalence of newly diagnosed hypertension was significantly higher ( $\chi^2=33.9$ , P<0.001). The prevalence of properly treated hypertension did not show significant difference ( $\chi^2=0.1$ , P=0.791), while the prevalence of improperly treated hypertension was significantly higher in island populations ( $\chi^2=21.8$ , P<0.001). Prevalence of respondents who reported having hypertension in their medical history was 30.5% in the mainland population and 25.1% in the island populations, what was significantly different ( $\chi^2=7.4$ , P=0.007) (Table 3).

**TABLE 2**  
THE PREVALENCE OF RESPONDERS WITH THE NORMAL BODY MASS INDEX, OVERWEIGHT AND OBESITY IN MAINLAND (CAHS) AND ISLAND (1001D) POPULATIONS; N (%)

Age group	BMI	Men		Women	
		CAHS	1001 D	CAHS	1001D
18–34	<25	284,969 (60.4)	78 (56.9)	369,171 (76.6)	132 (87.4)
	25.0–29.9	138,730 (29.4)	44 (32.1)	82,412 (17.1)	15 (9.9)
	>30	47,942 (10.2)	15 (10.9)	30,241 (6.3)	4 (2.6)
	$\chi^2$ , P	0.7, 0.705		10.0, 0.007	
35–49	<25	129,451 (29.1)	21 (16.2)	230,240 (46.7)	52 (39.4)
	25.0–29.9	217,689 (48.9)	81 (62.3)	175,810 (35.6)	62 (47.0)
	>30	97,911 (22.0)	28 (21.5)	87,400 (17.7)	18 (13.6)
	$\chi^2$ , P	12.3, 0.002		7.5, 0.024	
50–64	<25	102,829 (23.0)	16 (14.5)	123,634 (28.6)	22 (17.3)
	25.0–29.9	219,080 (48.9)	55 (50.0)	175,513 (40.6)	59 (46.5)
	>30	125,905 (28.1)	39 (35.5)	132,797 (30.7)	46 (36.2)
	$\chi^2$ , P	5.5, 0.063		8.0, 0.019	
over 64	<25	78,466 (29.1)	9 (10.0)	116,413 (27.2)	19 (16.7)
	25.0–29.9	132,713 (49.2)	59 (65.6)	184,256 (43.1)	46 (40.4)
	>30	58,547 (21.7)	22 (24.4)	127,173 (29.7)	49 (43.0)
	$\chi^2$ , P	16.5, <0.001		11.6, 0.003	
All ages	<25	595,715 (36.5)	124 (26.5)	839,458 (45.7)	228 (43.0)
	25.0–29.9	708,212 (43.4)	240 (51.3)	617,992 (33.7)	184 (34.7)
	>30	330,305 (20.2)	104 (22.2)	377,610 (20.6)	118 (22.3)
	$\chi^2$ , P	20.5, <0.001		1.7, 0.414	
AAP*	<25	37.6	28.3	48.3	47.1
	25.0–29.9	43.2	50.7	32.4	32.5
	>30	19.2	21.0	19.3	20.4

\*Age adjusted prevalence (percent), using new standard European population.

**TABLE 3**  
THE PREVALENCE OF BLOOD PRESSURE GROUPS IN THE MAINLAND (CAHS) AND ISLAND (1001D) POPULATIONS; N (%)

Age group	Blood pressure category	Men		Women	
		CAHS	1001 D	CAHS	1001D
18–34	Normotensive	371,394 (78.3)	93 (68.4)	431,864 (89.8)	140 (92.1)
	Newly diagnosed	82,748 (17.4)	41 (30.1)	15,742 (3.3)	0 (0)
	Improperly treated HP	7,839 (1.7)	2 (1.5)	8,280 (1.7)	0 (0)
	Properly treated HP	12,318 (2.6)	0 (0)	25,055 (5.2)	12 (7.9)
	$\chi^2$ , P	17.8, (Fisher) <0.001		9.8, (Fisher) <0.001	
35–49	Normotensive	269,284 (60.3)	54 (43.2)	342,310 (69.1)	85 (64.4)
	Newly diagnosed	103,199 (23.1)	51 (40.8)	64,834 (13.1)	36 (27.3)
	Improperly treated HP	55,827 (12.5)	17 (13.6)	48,014 (9.7)	6 (4.5)
	Properly treated HP	18,556 (4.2)	3 (2.4)	40,093 (8.1)	5 (3.8)
	$\chi^2$ , P	24.0, <0.001		27.3, <0.001	
50–64	Normotensive	159,417 (35.8)	26 (23.6)	158,528 (36.6)	27 (21.1)
	Newly diagnosed	128,433 (28.8)	48 (43.6)	96,802 (22.3)	46 (35.9)
	Improperly treated HP	119,463 (26.8)	31 (28.2)	131,146 (30.3)	46 (35.9)
	Properly treated HP	38,279 (8.6)	5 (4.5)	46,915 (10.8)	9 (7.0)
	$\chi^2$ , P	15.1, 0.002		22.1, <0.001	
over 64	Normotensive	57,866 (21.4)	9 (10.0)	75,278 (17.6)	16 (13.9)
	Newly diagnosed	81,046 (30.0)	43 (47.8)	91,799 (21.4)	31 (27.0)
	Improperly treated HP	103,568 (38.4)	36 (40.0)	202,754 (47.3)	63 (54.8)
	Properly treated HP	27,498 (10.2)	2 (2.2)	58,698 (13.7)	5 (4.3)
	$\chi^2$ , P	20.6, <0.001		11.2, 0.011	
All ages	Normotensive	857,961 (52.4)	182 (39.5)	1,007,981 (54.8)	272 (51.3)
	Newly diagnosed	395,426 (24.2)	183 (39.6)	269,177 (14.6)	125 (23.6)
	Improperly treated HP	286,697 (17.5)	87 (18.8)	390,193 (21.2)	115 (21.7)
	Properly treated HP	96,651 (5.9)	10 (2.1)	170,761 (9.3)	18 (3.4)
	$\chi^2$ , P	72.0, <0.001		50.0, <0.001	
AAP*	Normotensive	54.5	43.4	57.1	51.7
	Newly diagnosed	24.0	37.6	14.0	22.8
	Improperly treated HP	16.0	16.7	19.9	21.9
	Properly treated HP	5.6	2.3	9.0	3.6

HP – hypertension; \*Age adjusted prevalence (percent), using new standard European population.

## Discussion

The higher prevalence of some cardiovascular risk factors in the island populations represents the main finding of this study. The prevalence of increased body weight was higher in the islands, the prevalence of normotensive respondents lower, and the prevalence of treated hypertension groups less favorable. These findings are truly contrary to the expected pattern since it is traditionally believed that islanders are leaner and healthier, because of the traditional lifestyle that included Mediterranean diet, less exposure to stress and overall more favorable lifestyle.

The analysis of body mass index revealed an interesting pattern – both men and women in the youngest age groups were either similar or even leaner in islands,

while older age groups of islanders become more often overweight and obese. In the entire sample analysis we found that men were more frequently overweight and less frequently had normal body mass index. In addition, men were more likely to have newly measured hypertension, suggesting either limited access to the health care and preventive medical examination or decreased health awareness resulting in the low interest and exposure to health care. Similar findings were recorded in women, suggesting that the focus on preventive health was low in this population, possibly due to difficulties in accessing the health care. This finding was described in Croatia earlier, suggesting that access to health care was the strongest predictor for cancer screening uptake<sup>41</sup>. Additionally, there were less respondents with properly treated hypertension in the islands, suggesting that exposure

to specialist health care was also lower, if we assume that the effective treatment of hypertension is relatively difficult to obtain, and requires often consults with specialists. Therefore, we could as a conclusion say that the hypertension prevalence in the islands populations might be modulated by the poor access to health care, which might also be aggravated by the local population less willingness to participate in health promotion and disease prevention activities.

However, there is still a paradox in this situation. Coastal parts of Croatia have much lower cardiovascular mortality rates than continental<sup>42</sup>. It could either be that population in the coastal parts of Croatia has strong protective mechanisms by which they manage to maintain low mortality despite high prevalence of risk factors, or this could simply be the result of demographic changes that some islands might have experienced during the 1991–1995 war<sup>43</sup>. If the island population has changed to a sufficient level by immigrants from the continental parts of Croatia or other countries, we could hypothetically expect to observe increase in the cardiovascular mortality in the islands, which is not detectable at the moment as most of immigrants might have been middle-aged or younger, thus not belonging to the elderly age groups that mostly contribute to cardiovascular mortality. Some recent studies have confirmed that the genetic

makeup of the island populations shows varying levels of heterozygosity<sup>2</sup>, which could have effects on health<sup>44–47</sup>. Further research that would enable disentangling of this paradox could be made by the follow-up studies or cohort studies, which would provide life-long or longer-term estimates and enable the comparison between the island and mainland population. Additionally, we could perform any of the migration type studies, and investigate the risk factors prevalence and life-long morbidity and mortality of migrants both from and into the islands.

The main shortcoming of this study is related to difficulties in obtaining the representative data for the island population, due to the complexity of cultural, social, behavioral and genetic factors that all might have a substantial influence on the analyzed traits. This is extended to the problem of enumeration and inclusion of seasonal migrants. Finally, the recall bias might distort the results since medical history data were self-reported. Nevertheless, the results of this study suggest that islanders' health should be re-examined, based on the findings from previous studies<sup>48</sup> and this one, and that we may no longer associate islanders with the healthier lifestyle and health-related outcomes.

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## USPOREDBA PREVALENCIJE POVEĆANE TJELESNE TEŽINE I POVIŠENOG KRVNOG TLAKA IZMEĐU STANOVNIKA KOPNE NE HRVATSKE I JADRANSKIH OTOKA – JESU LI OTOČANI UISTINU ZDRAVIJI?

### SAŽETAK

Cilj istraživanja bio je usporediti prevalenciju povećane tjelesne težine (ITM) i povišenog krvnog tlaka između stanovnika kopnene Hrvatske i jadranskih otoka. Podaci za studiju dobiveni su iz Hrvatske zdravstvene ankete (N=9.070) kao izvora podataka za kopnenu Hrvatsku, i iz istraživačke studije »1001 Dalmatinac« (N=1.001) kao izvora podataka sa četiri jadranska otoka; Raba, Visa, Lastova i Mljet. Prevalencije povećane tjelesne težine i povišenog krvnog tlaka izračunate su za četiri dobne skupine i analizirane korištenjem hi-kvadrat testa. Rezultati upućuju na to da muškarci na otocima rjeđe imaju normalnu tjelesnu težinu ( $P < 0,001$ ) i veću prevalenciju povećane tjelesne težine ( $P < 0,001$ ). Među ženama nije zabilježena statistički značajna razlika u prevalenciji povećane tjelesne težine između otočana i stanovnika kopna. Postotak ispitanika s normalnim krvnim tlakom bio je manji na otocima ( $P < 0,001$ ), dok je postotak novodijagnosticiranih ispitanika s povišenim krvnim tlakom kod oba spola bio veći na otocima ( $P < 0,001$ ). Rezultati upućuju da zdravstvena slika otočana nije tako povoljna, unatoč prikladnijem životnom stilu i mediteranskom načinu prehrane, barem u smislu prevalencije čimbenika rizika za nastanak kardiovaskularnih bolesti. Ovakav nalaz bi, osobito među muškarcima, mogao biti posljedica otežanog pristupa zdravstvenoj službi, odnosno manje brige za preventivne preglede i kontrolu zdravlja, što je mogući uzrok većoj pojavnosti novodijagnosticiranih ispitanika s povišenim krvnim tlakom i manjoj prevalenciji ispitanika s prikladno liječenom hipertenzijom. Dobiveni rezultati upućuju na to da su otočne populacije prikladne za javnozdravstvene intervencije i akcije kojima je cilj promicanje zdravlja i prevencija bolesti.