Micro-scale Socioeconomic Inequalities and Health Indicators in a Small Isolated Community of Vis Island, Croatia

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Aim To investigate whether socioeconomic inequalities at a micro-scale, through their effect on major health risk factors and other health indicators, contribute to health status in an isolated island population with demonstrated reduced genetic and environmental variability.

Methods This cross-sectional study was performed in 2003 and 2004 in the adult population of the island of Vis, Croatia. Participants were recruited from the electoral register. A total of 1024 participants were included in the study, which represented a response rate of approximately 70%. The level of education and household socioeconomic status were used as the socioeconomic status indicators. Associations of these indicators with hypertension, obesity, hyperlipidaemia, smoking, diet indicators, and supplementary vitamins and calcium intake were investigated. Data analysis was performed by multivariate methods.

Results Age and gender were most commonly associated with the presence of major health risk factors. Level of education did not show significant association with any of the investigated risk factors, supplements intake, or with dietary habits. Household socioeconomic status was significantly associated only with excessive alcohol intake (logistic regression odds ratio [OR], 1.85; 95% confidence interval [CI], 1.12-3.07, $P = 0.016$), obesity (OR, 1.78; 95% CI, 1.13-2.81 $P = 0.013$), and high-fat diet (multiple linear modeling $F = 2.75$, $P = 0.042$).

Conclusion In isolated communities, socioeconomic stratification may be a less important health determinant than in large general populations, making these populations favorable resource for biomedical research into other health risk factors.

The effect of the socioeconomic inequalities on human health has been recognized since the earliest written evidence in all major human civilizations, but it has been intensively and systematically investigated since the 18th century (1). This research area encompasses a junction of various health and non-health related disciplines, and consistently suggests the presence of the strong adverse effects of the lower socioeconomic status. Socioeconomic inequalities are present across the world (1-3), and they are among the most important determinants of the cardiovascular (4-6) and cancer morbidity and mortality (7,8).

There are at least several possible explanations how socioeconomic inequalities influence health (9). However, the common premise for all these theories is the presence of measurable indicators that should express a substantial variation spectrum within a population, to allow for their use in the inequalities estimation and correlation with health status. It would be of interest to set a lower limit to this general phenomenon and investigate whether socioeconomic inequalities on a micro-scale, such as those occurring in the populations that are more uniform, are still as important determinants of health as other major environmental and hereditary factors.

Human isolated populations present an interesting model for this kind of research. Theoretically, these populations will be comprised of the genetical relatives (due to the limited population sizes) and also will share a substantial proportion of the environment, which should all act to reduce their socioeconomic inequalities and their impact on health. Croatian Adriatic islands represent a well-characterized meta-population of genetic isolates, with exceptionally well-documented demographic history, environmental exposures, and genetic structure (10-13). Therefore, the aim of this study was to determine the effect of socioeconomic inequalities on health at a micro-scale level in an isolated island population of Vis, where we previously demonstrated reduced genetic and environmental variability (14,15).

Materials and methods

Study population

The data for this study were collected during May 2003 and April 2004 in two villages – Komiža and Vis on the island of Vis, Croatia. The research team comprised researchers from the Andrija Štampar School of Public Health of the Zagreb University School of Medicine and the Institute for Anthropological Research in Zagreb, Croatia. Examinees were recruited on the basis of the electoral register, which lists the persons who are permanently living on the island, as opposed to the official census, which tends to overestimate the true island's population. A postal invitation was sent to all registered individuals. The final data set consisted of 1024 individuals, with the response rate of approximately 70%. Each individual was examined by trained medical personnel (obtaining a number of phenotypic measurements), surveyed with a comprehensive questionnaire (including detailed information on their genealogies, lifestyle, diet, medical histories, and socioeconomic status), and provided blood samples for biochemical analyses. Other details on the program are given elsewhere (10-12). Each participant was asked to sign an informed consent before entering the study. The study was approved by the Ethical Committee of the Zagreb University School of Medicine.

Measurements of socioeconomic status, risk factors, and health

Two measures of socioeconomic status were used: 1) level of education measured as number of years spent in the education system and 2) socioeconomic status based on the questionnaire originally developed by Mastilica (16) and adjusted for this particular population. The questionnaire score was the sum of positive answers to a total of 16 questions that were related to material possessions within the household, which included: water pipeline, two TV sets, toilette that can be flushed, dishwasher, bathroom, computer, gas/central heating, more than 100 books, wooden floors, art paintings/pottery, telephone, car, video recorder, a cottage or another apartment, freezer, and a boat.

Hypertension was defined as either systolic blood pressure over 140 mm Hg or diastolic blood pressure over 90 mm Hg. The respondents having body mass index equal or over 30 were considered obese. Different types of hyperlipidemia were identified in relation to the the laboratory referent range: 1) LDL hyperlipidemia was defined when low-density lipoprotein (LDL) values were higher than 3.0 mmol/L, 2) triglycerides hyperlipidemia when triglyceride values were higher than 1.7 mmol/L, and 3) total cholesterol hyperlipidemia when total cholesterol was higher than 5.0 mmol/L.

Four different diet indices were defined, representing 4 major diet components: consumption of carbohydrates, fruit/vegetables, low-fat food, and high-fat food. Carbohydrates index was based on the questionnaire including 5 questions which covered sugar consumption in the following ways: adding sugar to food and drinks before tasting it, eating chocolate, eating jams and marmalade, and eating candies and cakes. Fruit and vegetables consumption index was defined as the intake of various vegetables and fruit, covering a range of leafy vegetables, roots, legumes, and fresh fruit. Low-fat index was based on six various questionnaire items, consumption of vegetable and olive oil, various fish, and other seafood. Finally, high-fat index was defined from the intake of animal fat, red meat, and other meat derivates. Each of the diet indices were calculated as the total sum of weekly reported consumption frequencies.

Smoking was coded as a binary variable and smokers were considered as those who were actively smoking at the time when the study was conducted, or had had quit within the last 5 years. Physical activity was also coded as a binary variable, with examinees who reported their daily involvement in the physical exercise considered as physically active. Supplementary vitamin and minerals intake was investigated for vitamin C, D, and A, and for calcium; these were all coded as binary variables. Alcohol intake was coded as a binary variable, and a person was considered as an excessive alcohol consumer if they reported a daily intake higher than the suggested amount 0.5 L of beer, 0.2 L of wine, or more than 0.03 L of hard liquor (15).

Statistical analysis

All results were presented as relative and absolute frequencies. Differences between socioeconomic sub-strata in frequencies of the collected data on risk factors and health were analyzed using Mann-Whitney test. To establish the association between socioeconomic status and health risk factors, multivariate methods were used. Logistic regression was applied for binary dependent variables, while general linear modeling was applied for numerical variables (4 diet indices). Analysis was performed with the Statistical Package for the Social Sciences, version 13.0.0 (SPSS Inc, Chicago, IL, USA), with significance set at $P<0.05$.

Results

The final sample consisted of 1024 respondents from the village of Komiža (n = 578) and the village of Vis (n = 446). There were 425 men (42%) and 599 women (58%) in the sample. We found significant gender differences in education level and socioeconomic status, but not in age (Table 1).

Table 1. Age, education level, and socioeconomic status in the sample of adult population of island Vis, Croatia

Variable	Men; median (25, 75 percentile)	Women; median (25, 75 percentile)	P*
Age	56.0 (46.0, 68.0)	56.0 (45.0, 70.0)	0.555
Education level	11.0 (8.0, 12.0)	9.0 (7.0, 12.0)	<0.001
Socioeconomic status†	10.0 (8.0, 12.0)	9.0 (7.0, 11.0)	<0.001

*Mann-Whitney test.
†Defined as the sum of 16 various material household possessions.

The multivariate analysis indicated that the age was a significant predictor for smoking, obesity, and hypertension status, but not for excessive alcohol intake or increased levels of total cholesterol, LDL cholesterol, and triglycerides (Table 2). Gender was only a significant predictor of excessive alcohol intake but not of smoking , where it exibited borderline significance, (odds ratio [OR], 0.75; 95% confidence interval [CI], 0.55-1.02, $P = 0.063$) and other major risk factors. Level of education showed no association with major health risk factors in this population. Socioeconomic status was associated with excessive alcohol intake and obesity, but not with other risk factors (Table 2).

The association between socioeconomic status and supplementary vitamins and calcium intake was significant only for female gender, while education level and socioeconomic status did not show a significant association with this indicator (Table 3).

The results of the multivariate model for the 4 diet components suggested that the age of the examinees was important in the prediction of diet pattern, except for fruit and vegetables consumption (Table 4). Gender was significantly associated with carbohydrates consumption ($P = 0.003$) and high-fat nutrients consumption ($P<0.001$). Socioeconomic status exhibited only an association with high-fat diet, which had a borderline statistical significance ($P = 0.042$) (Table 4).

Discussion

This study showed that both education level and socioeconomic status were not as strong determinants of risk behaviors and selected health indicators in a small isolated community of island Vis as they were in general populations. Decreased levels of genetic and

Table 2. Logistic regression models on the association between several behavioral risk factors and medical findings and socioeconomic inequalities in the population of island Vis, Croatia

Predictor variable	Odds ratios (OR) with 95% confidence intervals (CI) and P-values: smoking	excessive alcohol intake	obesity	hypertension	increased total cholesterol	increased LDL	increased triglycerides
Age	0.95 (0.93-0.96); <0.001	1.00 (0.99-1.01); 0.870	1.02 (1.01-1.04); <0.001	1.08 (1.07-1.10); <0.001	0.99 (0.98-1.00); 0.110	0.99 (0.98-1.00); 0.053	1.00 (0.99-1.01); 0.846
Gender:							
men (ref.)	1.00	1.00	1.00	1.00	1.00	1.00	1.00
women	0.75 (0.55-1.02); 0.063	0.10 (0.07-0.15); <0.001	1.19 (0.88-1.62); 0.251	0.76 (0.56-1.03); 0.079	0.94 (0.73-1.22); 0.659	0.99 (0.76-1.29); 0.951	1.04 (0.79-1.36); 0.798
Education level:							
lower 25% (ref.)	1.00; 0.935	1.00; 0.424	1.00; 0.539	1.00; 0.262	1.00; 0.655	1.00; 0.884	1.00; 0.786
26%-50%	1.10 (0.70-1.75); 0.686	1.19 (0.73-1.95); 0.489	0.86 (0.56-1.34); 0.511	0.76 (0.49-1.19); 0.235	0.98 (0.67-1.43); 0.906	1.08 (0.73-1.59); 0.699	1.17 (0.78-1.73); 0.448
51%-75%	1.14 (0.76-1.70); 0.522	0.98 (0.64-1.52); 0.943	0.77 (0.52-1.14); 0.193	0.98 (0.67-1.45); 0.931	1.09 (0.78-1.53); 0.603	1.12 (0.80-1.56); 0.529	1.04 (0.73-1.48); 0.825
over 75%	1.12 (0.64-1.97); 0.688	0.69 (0.37-1.28); 0.237	0.72 (0.40-1.27); 0.255	0.61 (0.34-1.11); 0.105	0.82 (0.50-1.33); 0.415	0.96 (0.59-1.57); 0.870	0.89 (0.53-1.51); 0.673
Socioeconomic status:							
below 25% (ref.)	1.00; 0.414	1.00; 0.017	1.00; 0.053	1.00; 0.782	1.00; 0.732	1.00; 0.566	1.00; 0.372
26%-50%	0.73 (0.49-1.09); 0.123	1.07 (0.70-1.65); 0.754	1.50 (1.03-2.17); 0.033	0.96 (0.67-1.38); 0.836	1.11 (0.81-1.53); 0.504	1.18 (0.86-1.62); 0.316	1.06 (0.77-1.48); 0.712
51%-75%	0.84 (0.53-1.32); 0.445	1.85 (1.12-3.07); 0.016	1.78 (1.13-2.81); 0.013	0.94 (0.60-1.48); 0.796	0.98 (0.67-1.45); 0.921	0.99 (0.67-1.46); 0.945	0.95 (0.64-1.43); 0.810
over 75%	1.15 (0.37-3.59); 0.815	3.06 (0.85-11.05); 0.088	2.62 (0.82-8.30); 0.103	1.73 (0.53-5.67); 0.367	0.73 (0.25-2.17); 0.571	0.80 (0.28-2.33); 0.682	0.29 (0.06-1.34); 0.112

Table 3. Logistic regression models on the association between supplementary vitamins and calcium intake and socioeconomic inequalities in the population of island Vis, Croatia

	Supplementary vitamin and calcium intake odds ratios with 95% confidence intervals (OR [95% CI]) and P-values			
Predictor variable	vitamin A	vitamin C	vitamin D	calcium
Age	0.99 (0.96-1.01); 0.203	0.98 (0.97-0.99); 0.046	1.00 (0.97-1.02); 0.808	1.00 (0.98-1.01); 0.472
Gender:				
men (ref.)	1.00	1.00	1.00	1.00
women	2.87 (1.34-6.17); 0.007	1.85 (1.17-2.91); 0.008	3.32 (1.32-8.34); 0.011	3.51 (2.37-5.18); <0.001
Education level:				
below 25% (ref.)	1.00; 0.875	1.00; 0.394	1.00; 0.536	1.00; 0.307
26%-50%	1.47 (0.57-3.81); 0.427	0.85 (0.43-1.67); 0.629	2.20 (0.77-6.28); 0.141	0.88 (0.52-1.49); 0.638
51%-75%	1.25 (0.52-2.99); 0.615	1.01 (0.57-1.76); 0.996	1.58 (0.57-4.36); 0.382	0.93 (0.59-1.46); 0.744
Over 75%	1.07 (0.30-3.80); 0.916	1.65 (0.80-3.41); 0.179	1.43 (0.33-6.29); 0.637	1.56 (0.85-2.86); 0.151
Socioeconomic status:				
below 25% (ref.)	1.00; 0.339	1.00; 0.834	1.00; 0.167	1.00; 0.305
26%-50%	0.75 (0.33-1.69); 0.491	0.91 (0.53-1.56); 0.730	1.00 (0.40-2.49); 0.994	1.07 (0.70-1.62); 0.766
51%-75%	0.96 (0.38-2.46); 0.931	0.97 (0.51-1.83); 0.924	0.63 (0.19-2.13); 0.456	1.18 (0.71-1.96); 0.527
over 75%	3.34 (0.60-18.63); 0.169	1.68 (0.42-6.80); 0.466	5.00 (0.82-30.23); 0.081	3.07 (0.95-9.96); 0.062

Table 4. General linear modeling results that investigated the association between four diet components indices and socioeconomic inequalities in the population of island Vis, Croatia

	Diet components (F; *P*)			
Predictor variable	carbohydrates	fruit and vegetables	low fat nutrients	high fat nutrients
Age	152.48; <0.001	0.10; 0.748	55.36; <0.001	22.49; <0.001
Female gender	9.03; 0.003	1.22; 0.269	0.09; 0.760	20.25; <0.001
Education level	1.95; 0.120	0.84; 0.474	0.73; 0.533	0.21; 0.888
Socioeconomic status	0.23; 0.878	1.60; 0.187	0.33; 0.802	2.75; 0.042
R^2 (%)*	17.1	8.0	7.9	3.7

*Percentage of variance explained by the general linear modeling.

environmental diversity have already been demonstrated in the population of the island of Vis (17), and now we confirmed that the socioeconomic differences were less expressed in relation to the investigated health related indicators.

Very poor association was shown between socioeconomic factors and smoking and biochemical measurements, especially in comparison with the effects of age and gender on those risk factors. The association was noted only for obesity and excessive alcohol intake. Interestingly, although not always statistically significant, we noted a positive association between socioeconomic status and obesity and excessive alcohol intake, which is in contrast with the findings in some general populations (18-20). Possible explanation for this inverse gradient might be related to the traditional lifestyle. Due to periods of extreme poverty in the history of the island, it is possible that people with lower socioeconomic status tend to have dietary pattern and overall lifestyle that is closer to the Mediterranean diet concept, which is associated with a number of beneficial health effects, such as protection against cardiovascular diseases and some cancers (21).

The second investigated association was between the education and socioeconomic status and supplementary health interventions (such as vitamins and calcium). Supplementary health interventions were shown to represent very useful indicators of health education and access to health care, which is known to be strongly associated with socioeconomic status in large general populations (2,3,6). In our study only the female gender was a major predictor of the intake of supplementary vitamins and calcium, which was in line with findings of other researchers (22), while education level and socioeconomic status did not show any significant association with this indicator. This is quite encouraging, as it shows that all socioeconomic subclasses of the population have similar level of health education and even possibly access to health care.

Finally, it is known that inappropriate dietary habits are very common in the lower socioeconomic strata of the general population (23-25). This was confirmed in this study only to a less extent and was not a general finding on the island of Vis.

The statistical analyses took into account a reasonable amount of possible covariates to correct for confounding effects. None of these procedures could identify educational and socioeconomic stratification on the island of Vis as a major determinant of health indicators in the local population, apart from excessive alcohol intake and obesity.

Limitations of this study include the use of survey data, which may be prone to various levels of uncertainty and recall bias. Theoretically, this might have the strongest effect on the dietary indices. Additionally, due to the complex nature of socioeconomic inequalities in general, and the possible existence of different micro level determinants than in the general population, socioeconomic indicators used in this study might not reflect the true socioeconomic inequalities within the investigated island population.

An important conclusion of this study is that small, isolated communities probably share more than the geographic location, climate, and diet. Tightly intertwined lives of the people living in small communities probably influence each other a lot more than they do in alienated large cities. Any information, including that on health, is passed around more rapidly and inclusively. People's lifestyles influence each other to a much greater extent, and such society is almost certainly a lot more sensitive to issues of inequity than the alienated society in large cities. One of the possible ways to further explore the extent of socioeconomic inequalities in small isolated communities is to explore them in island populations of various sizes, aiming to show whether the increase of the effective population size might be contributing to the presence of socioeconomic inequalities.

The results of this study suggest that socioeconomic inequalities affect the main health indicators much less in a homogenous population of island Vis than is the case in larger populations. However, it is worth noticing that, even with such reduced effects of social inequalities on health, some of the effects persisted, namely the effects on obesity and alcohol intake. This shows how strongly alcoholism and obesity are determined by societal factors, and how futile recent calls for investments into trying to establish "genetic basis" of these two factors are likely to be (26).

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