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Gender Differences in Body Build and Physiological Functions in the Adult Population of Yucatan, Mexico

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ABSTRACT

This study, conducted in 1994–95, evaluates differences in body build, blood pressure and respiratory functions between sexes and age groups of low socioeconomic strata individuals living in Merida, Yucatan, Mexico. The cross-sectional sample includes 344 males and 320 females, 20–98 years of age divided into six age groups (20–29, 30–39, 40–49, 50–59, 60–69 and 70+ years) by sex. Differences between age cohorts in height, weight, fatness, systolic blood pressure, and most respiratory variables (excluding expiratory reserve volume, minute ventilation and respiration rate) are greater among women than in men. The more marked secular trend in stature and bigger biological differences between age cohorts in women might have its beginning in 19th century when living conditions of women were worse than those of men. Only since the last decades of 20th century, migrations and improvements in living conditions might caused more drastic changes in women of low social strata than in men. Results of regression analysis show a greater relationship between studied variables in women than in men what confirms that women are less sensitive to environmental factors. A pattern of changes in minute ventilation (MV) with rising age of the cohorts differs between men and women (smaller differences appear in the women's cohort) Also a different pattern (MV) is seen in European populations. The latter may suggest existence of some adaptational phenomena to the local environment.

Introduction

This paper presents preliminary results of a project designed to study biological differences between various professional groups, including fishermen and physical laborer, in Yucatan, as possible consequences of different working conditions. This part of the study includes adult inhabitants of Merida City only,

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coming from the rather poor social strata. The problem, which is of interest in the present work, concerns differences between men and women in a biological response to environmental factors. The differences between sex 10-year-age cohorts in somatic and physiological variables vary for both sexes and this may be due to their different sensitivity to environmental conditions.

There has been expected that secular trend in most of studied biological variables caused by changes in environmental conditions would have been more marked in men than in women, as the women's organisms are more biologically stable according to their biological (reproduction) functions. The same should be observed for age changes (less manifested in women than in men), which are rather hard to follow using a cross-sectional sample, but such attempts have been made. However, this basic prospect, well know from the wide spectrum of the literature, have been not found in the studied Yucatan sample. The hypothesis tested is the following: The Merida sample has a specific background based on their previous living conditions which caused that biological changes observed in women's and men's organisms through generations and maybe with age manifest themselves in a little different way than those observed for the well described world populations.

The problem, which is very important, concerns the reasons of possible differences between age cohorts. These differences may be caused by secular trend and age-related changes in a different proportion. The adult population sample consists of a minimum of two generations (if we assume that the time for one generation is equal to 25 years), and observed differences between them may be induced by changes in living conditions. There are also regressive changes in the human organism with age, which occur immediately after or a little later than the peak value of most biological variables (usually after 30 years of age).

It is important to note that, by using longitudinal studies, real changes with age can be observed. Cross-sectional data are influenced by differences between generations caused by changes in living conditions (political and socioeconomic conditions, different opportunities for upward social mobility) within which the biological development of each generation occurs as well as by differential mortality. However, cross-cultural and comparative data are also very important for gaining a more accurate understanding of the complexities of aging.

Materials and Methods

This study examines a cross-sectional sample of residents of Merida and vicinity (Yucatan, Mexico). Three hundred forty four males and 320 females between 20–98 years of age were studied in 1994. The sample was further divided into six age groups by sex: 20–29, 30–39, 40–49, 50–59, 60–69 and 70+ years. Sample size per age group varied between 47 and 85 individuals. The concept of this study was to measure people from the most numerous social-class of the Merida population. The factory and blue-collar workers were selected. Most worked in different kinds of factories in the city of Merida. They worked producing different brands of soft drinks, food products, and in garment factories, which mostly employed women. All factory workers were studied, instead for those who refused to participate. Older, usually non-employed, subjects were members of factory workers' families or were living in shelters for the poor who had no families.

Education level varied from the illiterate to those who had not completed secondary school. Income levels varied between 900 NP (new pesos/month) for younger people to 300 NP/Mo. for older people at a time before the economic crisis at the end of 1994 when the value of the peso was 1US$ = 3.4NP.

The studied sample consists of three ethnic groups. Ethnicity was established by the origin of two surnames, which each individual has from a father and mother side. Two Maya surnames = Maya origin, two no Maya surnames = non-Maya origin, mixed surnames = Mestizos. In all six age groups the percentage (30%) of Mestizos is similar. In younger individuals the percent of Maya and non-Maya is also approximately 30 percent. Only the oldest persons are of non-Maya origin in 60 percent. These numbers reflect great migratory movements from rural areas of Yucatan Peninsula to Merida in this century.

Studied variables included: body height (anthropometer, in cm)[1], body weight (weighting scale, in kg), ten skinfolds measured by a skinfold caliper at: cheek, chin, axilla, over triceps, subscapular, abdomen, 10 rib, hip (suprailiac), thigh and shank[2], systolic and diastolic blood pressure (SBP, DBP – Korotkoff phase V, measured by mercurial sphygmomanometer), vital capacity (VC; the lung volume in liters measured from a complete expiration following a deep inspiration), forced expiratory volumes in liters per 1 minute (FEV_1; the lung volume in liters, measured after 1 second of forced expiration), tidal volume (TV; the expirational and inspirational volumes in liters during normal respiration), minute ventilation volume (MV; the volume of expired air in liters per minute measured over a minimum of one minute), Inspiratory reserve volume (IRV; the possible further inspiration in liters starting from the normal inspiration level), expiratory reserve volume (ERV; the possible further expiration in liters starting from the normal expiration level), respiration rate per 1 minute (RR). All respiratory variables were measured using Spirovit SP-200 produced by the Schiller Company. Two other indices were also calculated: body mass index (BMI = weight in kg/height in m^2) and Ziemssen index (VC in ml / height in cm).

The method selected for evaluation of biological differences between various age groups was first used by Shock[2,3]. This method is based on the calculation of differences between a variable at its peak value in the youngest cohort (or from the moment a variable begins to decrease, usually in the 30s, but may appear later, e.g. for weight in 50s, for TV in 60s), and its value in the oldest cohort (at about age 80, but having cross sectional data it may appear a little earlier). In those variables for which the differences continuously rise after the 25-year-old cohort (SBP, DBP, RR), a similar difference as noted above between two age cohorts (showing the beginning of rise and the oldest one) is calculated. Results are presented as a percentage of total changes (differences) to the values for individuals in the youngest cohort or at the pick value. To choose the best way of presentation of the present results, the words »rise and decline« are used instead of »increase and decrease« to distinguish two different phenomena, the differences between age groups and the real changes with age.

One of the questions in this work concerns the problem whether cross-sectional age and the ethnic group have an influence on studied variables after adjustment for other factors, and how it looks in different genders. For this purpose multiple regression analysis was applied for five variables (height, weight, SBP, VC, and MV), as dependent ones. Correlation matrix was used to estimate relationship between all variables, what allowed to select independent variables (factors). Not all correlated variables from the group of respiratory traits were selected; only, the one variable most correlated with the dependent variable was examined. In all cases, two more variables were included as independent ones; the age of individuals (from 20 to 90 years) and their ethnic background which is a discrete variable (1-Maya, 2-mixed, and 3-non-Maya).

To have a more clear picture about the last biological differences in men and women in Mexico, where such studies are rather scare, the present Yucatecan results for height were compared with data for five rural Zapotec-speaking communities in the Valley of Oaxaca in southern Mexico[5]. Differences between age groups in some respiratory traits were also compared with Polish data, as the examples of these changes in European populations[6].

Nowdays and a short history

The Peninsula of Yucatan is low limestone plain, characterized by tropical weather with three distinct seasons: rainy (May-September), cool with northern winds (October-January) and dry (February-April). Mean monthly temperatures vary from 23 to 28 degrees centigrade, and precipitation from 2 to 15 cm[7]. Merida, the capital of Yucatan state, is located in the northern part of Yucatan peninsula, 35 km from the Mexican Gulf of Mexico, in the region of sisal plantations. The population of Merida was 556,819 inhabitants in the 1990 census; 40.9 percent of all inhabitants of the state of Yucatan[8].

Almost all studied individuals were born in, or near to, Merida this century. There is a little known about changes in socioeconomic conditions in Merida from the beginning of this century. Between 1910 and 1927 the Mexican Revolution lowered the quality of life for all of Mexico, which is clearly evident by examining annual changes in GNP per capita for the nation during these years[7,9]. Then, from 1917 to 20 influenza and smallpox epidemics decimate the Indian population in Yucatan. For many years this was the region with the highest level of henequen production for light cordage for the entire world. Then from 1926 to 1934 an economic crisis occurred in which the production of henequen collapsed. This caused the increase in poverty, especially among families of henequen workers[10,11]. Beginning in the 30s, a continuous progression in economics was observed, characterized by smaller or larger fluctuations, which resulted in gradual improvements in living conditions. Life expectancy in Yucatan Peninsula also rose. It was 39.2 years in 1940, 49.6 in 1950, 57.9 in 1960, 60.2 in 1970, 66.1 in 1975, and 69.0 years in 1979[12].

Results

Differences between age cohorts and relationship between studied variables

The differences between six age cohorts in studied variables manifest themselves very distinctly. Some variables diminish their values immediately after the 25 (20–29) year old cohort (e.g. height, and some respiratory characteristics). Others rise in value together with the age of cohorts (SBP and DBP), or decline in older individuals belonging to the 55 (50– 59) or even 65 (60–69) year old cohorts (weight, fat tissue). These differences must be viewed in the context of both: age-associated variation and as a result of secular factors. Table 1 presents mean values and standard deviations of 20 variables, two indices and the sum of 10 fatfolds (Fat 10) in the six age groups (cohorts), separately for both sexes. The graphic presentation of this table is seen in the Figures 1 to 4.

Variables related to soft tissue, demonstrate great sensitivity to nutrition and physical activity. The sum of 10 skinfolds and weight rise until the 55 year old cohort and then decline by 21 and 17 percent in men and 25 and 18 percent in

TABLE 1
MEAN VALUES, STANDARD DEVIATIONS AND SAMPLE SIZE OF THE BIOLOGICAL CHARACTERISTICS FOR MALES EXAMINED IN INCREASING AGE GROUPS

Indices and Variables	Males						Females					
	Age groups (cohorts)											
	25	35	45	55	65	75	25	35	45	55	65	75
Height (cm)												
Mean	159.80	158.47	158.83	158.45	157.13	154.44	148.48	147.64	147.40	146.80	144.13	140.58
SD	5.9	5.9	5.3	5.1	6.3	5.4	5.6	5.3	6.2	6.5	5.6	6.2
N	85	68	58	56	50	47	57	59	54	48	49	53
Weight (kg)												
Mean	65.70	67.95	71.17	74.14	70.50	61.69	57.02	60.92	62.51	65.27	62.42	53.83
SD	9.5	9.6	11	11.9	12.4	10.8	8.2	10.7	12.4	10.0	11.1	11.6
N	85	68	58	56	50	47	57	59	54	48	49	53
BMI (kg/m^2)												
Mean	25.75	27.01	28.18	29.48	28.49	25.81	25.89	27.94	28.65	30.36	30.02	27.16
SD	3.61	3.08	3.87	4.21	4.29	3.99	3.63	4.72	4.65	4.94	4.89	5.32
N	85	68	58	56	50	47	57	59	54	48	49	53
Cheek skinfold (mm)												
Mean	7.90	8.00	8.62	9.30	8.66	8.34	10.18	10.98	11.43	11.69	11.37	10.26
SD	2.2	2.4	2.6	2.4	2.3	2.7	2.6	2.8	2.4	3.8	2.5	3.2
N	84	68	58	56	50	47	57	59	54	48	49	53
Chin skinfold (mm)												
Mean	7.44	8.47	9.43	10.32	9.32	8.06	9.56	11.12	12.04	11.98	1.55	9.40
SD	2.7	3.0	2.8	3.0	2.5	2.7	2.5	3.3	3.2	2.2	2.2	3.0
N	84	68	58	56	50	47	57	59	54	48	49	53
Midaxillary skinfold (mm)												
Mean	12.20	14.03	16.62	18.46	17.10	15.00	16.21	18.42	21.72	23.40	22.78	17.42
SD	5.3	5.2	6.2	6.2	6.0	5.1	6.9	6.6	6.2	6.8	7.2	8.4
N	84	68	58	56	50	47	57	59	54	48	49	53
Triceps skinfold (mm)												
Mean	9.19	9.16	8.88	10.59	8.60	8.34	14.14	17.86	17.87	20.00	17.69	13.94
SD	3.6	2.9	3.2	4.8	2.9	3.0	5.4	8.1	7.2	7.1	6.2	6.4
N	84	68	58	56	50	47	57	59	54	48	49	53
Subscapular skinfold (mm)												
Mean	16.93	18.09	20.29	22.23	19.58	16.55	22.67	27.00	29.78	31.40	28.43	21.70
SD	7.1	6.4	6.6	6.7	6.0	5.4	7.7	7.4	6.2	7.2	5.5	7.9
N	84	68	58	56	50	47	57	59	54	48	49	53
Abdominal skinfold (mm)												
Mean	17.25	19.84	21.17	22.52	18.92	18.55	27.35	29.78	33.52	38.23	36.14	29.69
SD	6.4	6.1	7.4	7.0	6.7	6.3	8.6	8.3	9.5	8.9	9.3	9.6
N	84	68	58	56	50	47	57	59	54	48	49	52
10 rib skinfold (mm)												
Mean	13.32	15.59	16.10	18.20	16.58	13.98	18.84	21.41	23.11	24.10	21.96	18.68
SD	6.0	4.9	5.8	4.4	5.6	5.2	5.7	7.2	8.6	7.3	6.3	7.1
N	84	68	58	56	50	47	57	59	54	48	49	53

TABLE 1
CONTINUATION

Indices and Variables	Males						Females					
	Age groups (cohorts)											
	25	35	45	55	65	75	25	35	45	55	65	75
Suprailiac skinfold (mm)												
Mean	16.57	19.35	18.91	20.57	19.02	15.55	24.89	27.22	27.50	30.50	29.31	23.09
SD	6.5	5.8	8.7	6.7	7.1	5.2	7.7	8.4	7.6	7.8	7.7	9.0
N	84	68	58	56	50	47	57	59	54	48	49	53
Tigh skinfold (mm)												
Mean	8.20	7.76	7.67	8.64	7.14	6.72	15.26	17.64	16.39	15.56	12.78	11.96
SD	2.8	2.4	2.8	3.4	2.6	2.1	5.7	7.4	6.3	7.6	6.6	8.3
N	84	68	58	56	50	47	57	59	54	48	49	53
Calf skinfold (mm)												
Mean	8.82	8.40	7.53	8.25	6.96	6.36	15.93	16.69	16.15	15.23	12.41	10.58
SD	4.3	3.4	3.7	3.5	2.8	2.2	5.1	7.0	6.1	6.2	6.1	6.3
N	84	68	58	56	50	47	57	59	54	48	49	53
Sum of 10 Skinfolds (mm)												
Mean	117.83	128.69	135.24	149.09	131.88	117.47	175.04	198.14	209.50	222.08	204.41	167.40
SD	38.0	30.9	38.9	33.5	35.4	30.2	41.7	45.4	42.2	42.6	39.6	54.6
N	84	68	58	56	50	47	57	59	54	48	49	52
Systolic blood Pressure (mm Hg)												
Mean	108.33	114.68	119.83	125.09	123.30	126.81	104.82	110.42	113.15	117.71	124.90	128.68
SD	12.1	13.1	13.7	22.8	18.1	23.2	12.8	15.3	19.5	19.3	16.6	21.1
N	84	68	58	56	50	47	57	59	54	48	49	53
Diastolic blood Pressure (mm Hg)												
Mean	76.25	79.93	81.90	82.86	81.40	76.70	73.16	78.05	79.81	78.96	80.41	79.34
SD	10.2	9.8	11.4	14.5	11.2	9.8	7.7	11.3	10.3	11.2	10.8	10.7
N	84	68	58	56	50	47	57	59	54	48	49	53
Vital capacity (l)												
Mean	4.54	4.28	4.17	3.71	3.28	2.67	3.20	3.09	2.83	2.33	2.07	1.70
SD	.7	.7	.7	.5	.6	.6	.6	.4	.5	.4	.4	.5
N	82	63	56	53	49	45	52	57	53	47	45	50
Ziemssen index (l)												
Mean	28.38	26.97	26.22	23.39	20.85	17.23	21.54	20.91	19.15	15.79	14.34	12.02
SD	4.0	4.0	3.7	2.9	3.4	3.9	3.5	2.7	3.2	2.6	2.8	3.0
N	82	63	56	53	49	45	52	57	53	47	45	50
Forced expiratory volume (l)												
Mean	4.06	3.84	3.74	3.42	2.98	2.32	2.93	2.84	2.64	2.18	1.92	1.51
SD	.6	.6	.7	.5	.5	.7	.6	.4	.5	.5	.4	.5
N	84	67	57	56	49	45	54	59	54	47	45	51

TABLE 1
CONTINUATION

Indices and Variables	Males						Females					
	Age groups (cohorts)											
	25	35	45	55	65	75	25	35	45	55	65	75
Inspiratory reserve volume (l)												
Mean	2.27	2.28	2.11	1.90	1.59	1.41	1.67	1.61	1.40	1.23	1.05	.83
SD	.5	.6	.5	.5	.4	.6	.3	.4	.4	.4	.4	.4
N	73	57	50	48	47	44	46	54	52	46	45	50
Expiratory reserve volume (l)												
Mean	1.50	1.24	1.17	.81	.73	.44	.93	.83	.75	.46	.40	.32
SD	.5	.5	.4	.3	.4	.3	.3	.3	.3	.3	.2	.2
N	73	57	50	48	47	44	46	54	52	46	45	50
Tidal volume (l)												
Mean	.78	.72	.90	.94	.96	.80	.56	.62	.68	.65	.60	.54
SD	.3	.2	.4	.4	.4	.3	.2	.3	.3	.2	.2	.3
N	84	67	58	56	50	45	57	59	54	47	47	52
Respiratory rate (per minute)												
Mean	17.54	19.66	17.58	17.99	20.14	20.74	21.68	20.27	18.73	19.72	20.08	20.53
SD	5.0	6.3	6.2	6.4	8.5	8.0	7.8	6.2	6.7	6.8	5.4	6.4
N	84	67	58	56	50	46	57	59	54	47	48	52
Minute volume (l)												
Mean	11.43	12.05	14.54	14.74	15.59	14.31	11.29	11.01	10.73	10.82	10.66	10.79
SD	4.0	4.0	6.8	7.7	6.5	5.8	4.6	4.3	4.4	4.2	4.1	4.7
N	84	67	58	56	50	46	57	59	54	47	48	52

women, respectively. (Figure 1, Table 1, Figure 5).

Systolic blood pressure rises with greater age of all cohorts (Figure 2, Figure 5). In men it rises by 17 percent, and in women by 23 percent when compared to the young-adult values. It is interesting that SBP is greater in men through the 55-year-old cohort; subsequently, blood pressure is higher in women. The rise of DBP is much smaller than observed for SBP (8% in women and not significant differences in men).

Most of the respiratory measures studied show a statistically significant decline after the 25-year-old cohort. This decline is mostly marked in expiratory reserve volume (ERV) which by the 75 (70+) -year-old cohort is 71 percent lower in men and 66 percent lower in women compared to the young adult capacity (Figure 3, Figure 5). Other respiratory characteristics such as FEV_1, VC and IRV continuously decline with older age of cohorts to about 40 percent in men and 50 percent in women compared to the capacity in 25-year-old cohort. Ziemssen index, which measures VC for height, shows the same pattern and level of differences as observed for VC. Tidal volume declines in men after the 65 (60–69)-year-old cohort to 16 percent and in women after the 45 (40–49)-year-old cohort to 20 percent of youthful capacity (Figure 4). Respiration rate (RR) per minute rises in men after the 45-year-old cohort by 18 percent, in

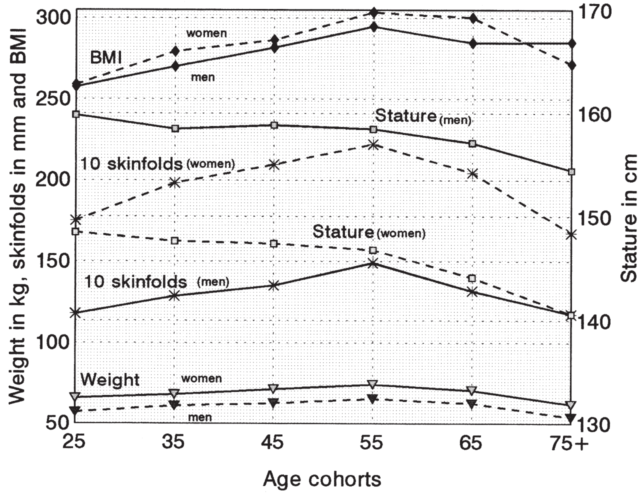

Fig. 1. Values of somatic variables for each age cohort in the Merida adult population.

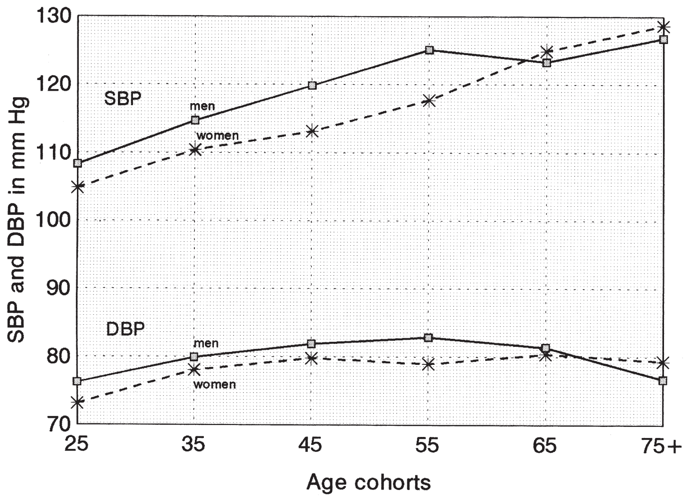

Fig. 2. Values of systolic and diastolic blood pressure for each age cohort in the Merida adult population.

women these differences are not statistically significant.

Differences in minute ventilation (MV) between the cohorts are the most distinct between men and women (Figure 4, Figure 5). In men, MV rises by 25 percent above the young-adult values until the 75-year-old cohort, but in women it slowly declines by 5 percent and shows no statistical significance. This picture is different from that observed in European populations where MV declines in both

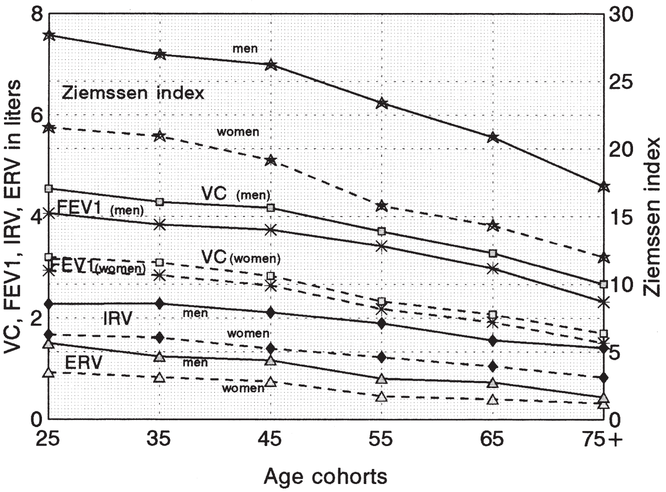

Fig. 3. Values of respiratory variables (VC, FEV1, IRV, ERV and Ziemssen index) for each age cohort in the Merida adult population.

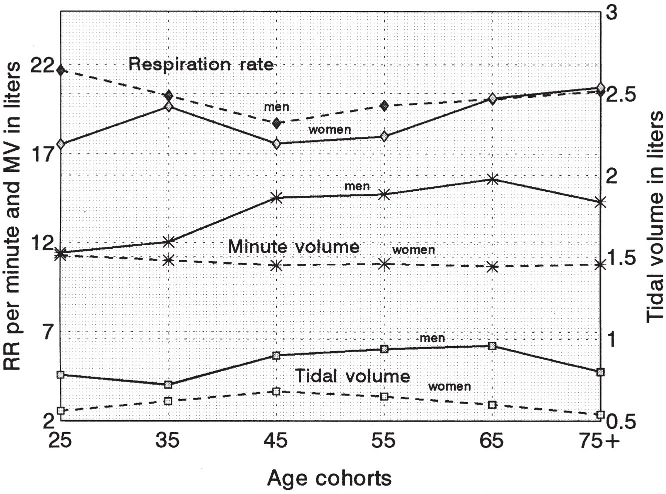

Fig. 4. Values of respiratory variables (RR, MV and TV) for each age cohort in the Merida adult population.

sexes with age of samples (cross-sectional material), and the decline occurs a little later in men (Figure 6).

All respiratory measures manifest greater values in men than in women, but only for ERV, MV and RR the differences between cohorts are smaller in women.

Multiple regression analysis allowed to examine the relationship between studied variables.

TABLE 2
DIFFERENCES BETWEEN 10-YEAR-GROUPED INDIVIDUALS OBSERVED FOR SOME BIOLOGICAL CHARACTERISTICS IN A DECREASING ORDER OF THE TOTAL PERCENT OF CHANGES, SEPARATELY FOR RISING AND DECLINING TENDENCY OF CHANGES

Vari-ables	Age ranges of	Males			Females			Total % of changes	
	Observed changes	Changes in raw values	T-test	P	Changes in raw values	T-test	P	M	F
				Declining tendency					
ERV	25–75	–1.06 l	15.91	p <0.01	–0.61 l	10.32	p<0.01	70.72	65.96
IRV (F)	25–75				–0.84 l	11.15	p<0.01		50.27
FEV1	25–75	–1.74 l	14.56	p<0.01	–1.43 l	13.83	p<0.01	42.80	48.65
VC	25–75	–1.87 l	14.75	p<0.01	–1.05 l	14.23	p<0.01	41.25	46.88
IRV (M)	35–75	–0.87 l	7.51	p<0.01				38.18	
Fat 10	55–75	–31.62 mm	4.99	p<0.01	–54.68 mm	5.55	p<0.01	21.21	24.62
TV (F)	45–75				–0.14 l	2.74	p<0.01		20.35
Weight	55–75	–12.45 kg	5.51	p<0.01	–11.44 kg	5.28	p<0.01	16.79	17.52
TV (M)	65–75	–0.15	1.93	NS				15.98	
Height	25–75	–5.36 cm	5.14	p<0.01	–7.9 cm	7.03	p<0.01	3.35	5.32
MV (F)	25–75				–0.49	0.56	NS		4.96
				Rising tendency					
MV (M)	25–75	2.88 l	–2.99	p<0.05				25.20	
RR (M)	45–75	3.16 p/min	–2.27	p<0.05				17.98	
SBP	25–75	18.48 mm Hg	–5.09	p<0.01	23.86 mm Hg	–7.1	p<0.01	17.05	22.76
RR (F)	45–75				1.8 p/min	–1.42	NS		9.63
DBP	25–75	0.45 mm Hg	–0.25	NS	6.18 mm Hg	–3.50	p<0.05	0.33	8.45

M - males; F - females

Regression analysis of height in relation to age and ethnicity shows that only about 9 percent of the variance of height in men and 26 percent in women are explained by these two variables. Age is more closely related to height than the ethnic background (Table 3).

When weight is the dependent variable, fat and height in both sexes and age in women are most closely associated with this variable. Eighty four percent of the weight variance is explained by four variables (Table 4).

Regression analysis of SBP in relation to age, ethnicity, fatness and ERV shows that 15 percent in men and 29 percent in women of the SBP's variance is explained by these 4 variables. For males only age and fatness are significantly related to SBP, whereas for women age, fatness, ERV and ethnicity are all related significantly, in the decreasing order, to SBP (Table 5).

Regression analysis of VC in relation to age, height, SBP and ethnic group shows that 58 percent of the VC variance in men and 68 percent in women is explained by 4 variables. Only age and height are significantly related to VC (Table 6).

Minute ventilation volume (MV), which is slightly correlated with other

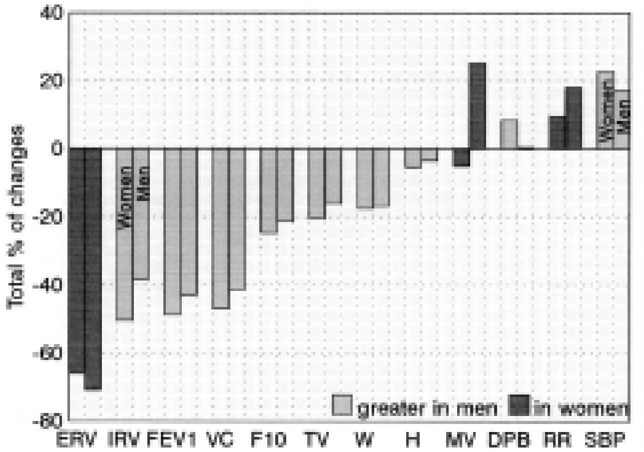

Fig. 5. Differences in some biological variables between the age cohorts 25 and 75. The order from maximal decrease to maximal increase in women (in percent). Abbreviations: F10 – Fat 10; W – Weight; H – Height.

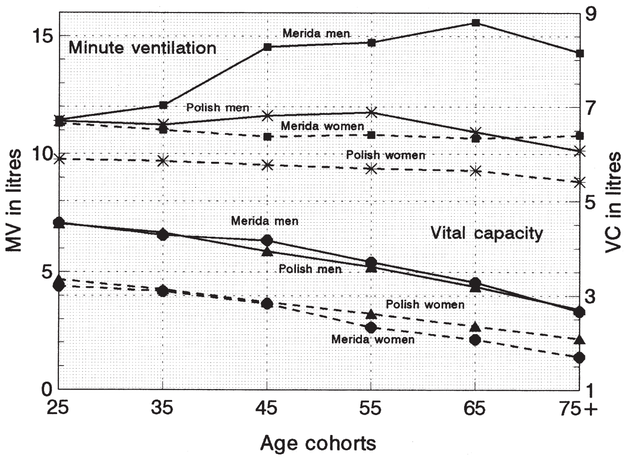

Fig. 6. Values of minute ventilation (MV) and vital capacity (VC) for each age cohort in the Merida (Mexico) and Polish populations.

variables, shows a different picture for men and women. Ten percent of its variance is explained by three variables in men (age, ethnicity and weight), and only 2 percent are explained by these three variables in women. Weight and age are related to MV in men. But in women only ethnic group is very slightly related to MV (Table 7).

The above indicates that except MV, the relationship between studied variables is stronger in women than in men.

TABLE 3
REGRESSION ANALYSIS OF SUBJECTS' HEIGHT ON AGE AND ETHNIC GROUP

Merida adults	R	R^2	Partial Corr.^{2}	Regression coefficient (b) SE_b	t	p
MALES	.2969	.0882				
Age			.0737	–.09117 .01711	–5.33	p < .01
Ethnic group			.0379	1.40583 .37485	3.75	p < .01
FEMALES	.5113	.2615				
Age			.2214	–.16142 .01708	–9.45	p < .01
Ethnic group			.1074	2.60272 .42327	6.15	p < .01

TABLE 4
REGRESSION ANALYSIS OF SUBJECTS' WEIGHT ON AGE, ETHNIC GROUP, FAT TISSUE AND HEIGHT

Merida adults	R	R^2	Partial Corr.^{2}	Regression coefficient (b) SE_b	t	p
MALES	.83877	.7035				
Fat10			.6245	.22287 9.18524E–03	24.26	p < .01
Height			.2824	.69629 .05899	11.80	p < .01
Age				.02047 .01978	1.03	NS
Ethnic group				–.03027 .42562	–.07	NS
FEMALES	.83675	.7001				
Fat10			.6348	.17190 7.39297E–03	23.25	p < .01
Height			.2017	.57278 .06461	8.87	p < .01
Age			.0231	.05960 .02197	2.71	p < .01
Ethnic group				.52231 .50681	1.03	NS

Biological Differences in Adult Man and Women in Merida and in the Valley of Oaxaca, Mexico

The decline in height of the Merida adults is compared with data for five rural Zapotec-speaking communities in the Valley of Oaxaca in southern Mexico[5]. The effects of age and secular factors on adult stature are evaluated using linear regression of stature and stature adjusted for the estimated effects of aging after 30 years of age on year of birth. The Trotter and Gleser[13] prediction of the aging process (0.06 cm per year) is used, estimated for Blacks and Whites, males and females after the age of 30 years. For the Merida sample the Panek's value of 0.04 cm per year is also used[14]. It had been estimated for members of the Polish population born between 1909–1947, which had suffered during World Wars I and II (Table 8). Historically speaking, both Polish and Yucatecan populations had economic crises and social disturbances during the first 50 years of this century. A most important observation concerning

TABLE 5
REGRESSION ANALYSIS OF SUBJECTS'SYSTOLIC BLOOD PRESSURE ON AGE, ETHNIC GROUP, SUM OF 10 FAT FOLDS AND ERV

Merida adults	R	R^2	Partial Corr.^{2}	Regression coefficient (b)	SE_b	t	p
MALES	.3840	.1475					
Age			.0642	.34218	.07431	4.61	p < .01
Fat 10			.0315	.09013	.02842	3.17	p < .01
Ethnic group				–.52222	1.25778	–.41	NS
ERV				–.32796	2.47848	–.13	NS
FEMALES	.5428	.2941					
Age			.0864	.35570	.06864	5.18	p < .01
Fat 10			.0344	.06508	.02046	3.18	p < .01
ERV			.0290	–9.92228	3.40706	–2.91	p < .01
Ethnic group			.0231	3.38121	1.30338	2.59	p < .05

TABLE 6
REGRESSION ANALYSIS OF SUBJECTS' VITAL CAPACITY ON AGE, ETHNIC GROUP, HEIGHT AND SYSTOLIC BLOOD PRESSURE

Merida adults	R	R^2	Partial Corr.^{2}	Regression coefficient (b)	SE_b	t	p
MALES	.7592	.5764					
Age			.3807	–.02889	2.00396E–03	–14.42	p < .01
Height			.2193	.05410	5.55157E–03	9.74	p < .01
Ethnic group				–.01960	.04032	–.49	NS
SBP				–7.38871E–04	1.82518E–03	–.41	NS
FEMALES	.8218	.6754					
Age			.4191	–.02341	1.60193E–03	–14.61	p < .01
Height			.2237	.04032	4.36546E–03	9.23	p < .01
SBP				–2.49699E–03	1.42900E–03	–1.75	NS
Ethnic group				.05460	.03546	1.54	NS

the Merida sample is that among women differences between the age cohorts are much more pronounced than among men. If age related changes are eliminated, the secular trend of 0.25 cm per decade in men of Merida, which is not statistically significant, is seen. In Zapotec males it is 0.57 cm per decade. In Merida women it is 0.90 cm per decade, and in Zapotec women – 0.08 cm per decade.

These findings emphasize that secular changes in Merida are lower in men and are greater in women than in the Oaxaca rural community observed about 20 years earlier. Additionally, height measurements adjusted by the Panek's method

TABLE 7
REGRESSION ANALYSIS OF SUBJECTS' MINUTE VOLUME ON AGE, ETHNIC GROUP AND HEIGHT AND WEIGHT

Merida adults	R	R^2	Partial $Corr^2$	Regression coefficient (b)	SE_b	t	p
MALES	.3193	.1020					
Weight			.0558	.12381	.02710	4.57	p < .01
Age			.0502	.07538	.01745	4.32	p < .01
Ethnic group				–.25168	.38756	–.65	NS
FEMALES	.1410	.0199					
Ethnic group			.0149	–.73169	.33749	–2.17	p < .05
Weight				.02273	.02206	1.03	NS
Age				–8.30216E–03	.01352	–.61	NS

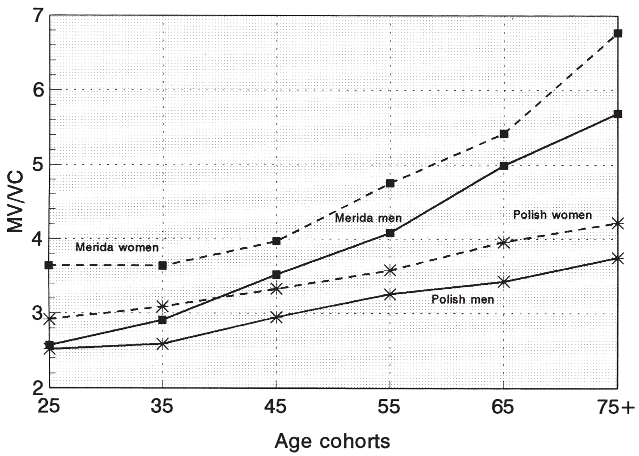

Fig. 7. Changes in minute ventilation (MV) for vital capacity (VC) for each age cohort in the Merida (Mexico) and Polish populations.

show that secular changes in women (1.1 per decade) are more than twice as large as those of men (0.44).

Discussion

It has been found in the literature that the decline of somatic, cardio-vascular and respiratory characteristics is more marked in men than in women[15], and that the rate of this decline depends on life style and nutrition during one's entire lifespan[16]. Also many publications reporting secular changes, mostly in stature, in European populations, evaluate them as equal 1 cm per decade in men, and that this trend is less marked in women[17–20]. As it is observed in the studied Merida sample the decline of most variables is more marked in women than in men, and this might be caused by some external factors.

TABLE 8
REGRESSION OF STATURE AND ADJUSTED STATURE WITH YEAR OF BIRTH IN MERIDA AND OAXACA ZAPOTEC ADULTS

Samples studied	r	Regression coefficient (b)	SE_b	t	p
Merida adults					
Males (n=364)					
Stature	0.24	0.080	0.017 cm/yr	4.77	$p < 0.01$
Adjusted stature I[1]	0.08	0.025	0.017 cm/yr	1.49	NS
Adjusted stature II[2]	0.13	0.044	0.017 cm/yr	2.59	$p < 0.05 > 0.01$
Females (n=320)					
Stature	0.42	0.146	0.018 cm/yr	8.28	$p < 0.01$
Adjusted stature I	0.28	0.090	0.018 cm/yr	5.12	$p < 0.01$
Adjusted stature II	0.33	0.109	0.018 cm/yr	6.18	$p < 0.01$
Zapotec adults[3]					
Males (n=277)					
Stature	0.27	0.102	0.022 cm/yr	4.64	$p < 0.01$
Adjusted stature I	0.15	0.057	0.022 cm/yr	2.58	$p = 0.01$
Females (n=225)					
Stature	0.17	0.051	0.020 cm/yr	2.50	$p < 0.05 > 0.01$
Adjusted stature I	0.03	0.008	0.020 cm/yr	0.39	NS

[1] Adjusted for age-associated stature loss after the age of 30 years (0.06 cm/yr) after Trotter and Gleser (1951).

[2] Adjusted for age-associated stature loss after the age of 30 years (0.04 cm/yr) after Panek (1978).

[3] Data after Malina et al. (1983).

Regression analysis applied for height as dependent variable with the age and ethnic group as independent ones revealed that differences in height observed between six age-cohorts are more related to age than to ethnicity. The percent of height variance explained by these variables is much greater among females (26%) than males (9%). It has been postulated that decline in stature with age results from vertebral body fractures, compression of intervertebral discs, and postural changes with age[21]. These kinds of changes can only be measured precisely using longitudinal data. However, in evaluation of changes with age many authors have based their study on semi-longitudinal and cross-sectional data[13,14,22]. Estimated rates of stature loss with age vary among different populations, with males showing greater stature loss than females[23] or with females showing decline in stature more pronounced than males[24,25].

Even though the real age changes of stature are a little different than age differences assumed for the Merida sample (Table 7), or they are not equal for both sexes, the fact that secular changes in women are more expressed than in men appears to be very significant. There are other data for Yucatan showing that between years 1895–1968 changes in height are not significant[26]. According to Kelley's data[27] the differences between the stature of mothers and their daughters in Yucatan state (measured in 1985) have shown the significance of changes in urban areas equal 0.13 cm per year. Wolanski's data[28] of middle social class residents of Merida and Progreso (a little port town near Merida) have shown greater changes in height among the women of Progreso (0.17 per year) than among the men of Progreso (0.11 per year), but in the Merida's middle social class residents changes are greater among men (0.19 per year) than women (0.12 per year).

Changes of body weight with age and its differences between age cohorts also show populational and regional differences based on cultural and/or socioeconomic differences connected with physical activity and nutritional habits. For the Merida sample, a rise of body weight, BMI and fatness (the sum of 10 fat skinfolds) is observed until the 55-year-old cohort and then in the two older cohorts the gradual decline takes place (Figure 1). This is similar for both sexes. Other evidences point out that women's weights peak at a later age, and decline more slowly thereafter[16,29] than it is observed in men. Also results presented by Malina et al.[30] for rural Oaxaca Indians, show different patterns of changes between age groups related to weight and fatness in both sexes. The researchers found a rise of weight and fatness in women until age 60 and in men only until 40–45, followed by a decline in both sexes. The present results show that age does not demonstrate the relation to weight in men. Among women this relation is rather weak (only 2% of the weight variance is explained by age). Neither ethnicity illustrates the significant relation to weight. There is the rather strong relation of fatness and height to weight. This illustrates that observed differences in weight between six age cohorts could be caused by factors other than age and ethnicity. For example, the first four age cohorts might be composed of individuals with stronger body builds than is true for the final two.

A rise in SBP and DBP, especially in modern, developed countries, has been a very important factor related to coronary, stroke and renal diseases[31,32]. Hypercaloric diet and low level of physical activity, both of which can be manifested as an increase in skinfold thickness, can also cause an increase in BP. In the Merida sample, it is observed that SBP and DBP are greater among men through the 55-year-old cohort, and subsequently, blood pressure is higher among women (in the 65 and 75-year-old cohorts). Similar results have been found in traditional and modernizing Pacific populations: among Melanesians, Micronesians and Polynesians[33]. In the Schall's and present data young men have higher SBP (from 1 to 5 mm Hg; 3.5 for Merida) than do young women, and older men have lower SBP (from 2 to 9 mm Hg; 1.87 for Merida) than do older women. Data for DBP do not necessarily follow the pattern characteristic for SBP. The suggestion that women are less sensitive to environmental factors accompanying modernization than are men, and that their hypertension might be more closely associated with aging than in men is logical. However, a lower value of SBP in men than in women after the 60-age-old cohort could also be related to a higher mortality of men in their 50s from coronary heart diseases and perhaps other illnesses exacerbated by high blood pressure. The results of regression analysis show that in men six percent and in women nine percent of the SBP variance is explained by age, and three percent of this variance is explained by fatness in both sexes. It is not much, but for men these are the only variables related to SBP. For women, there are two more; ERV and ethnicity, explaining the variance of BP from two to three. Also interesting is the fact that among women there is an association between a greater amount of air residing in the lungs after expiration (ERV) with a lover SBP value. This suggests that this associative phenomenon needs further investigation. The connection with ethnicity and fatness suggests that beside changes with age in the older cohorts, more women of non-Maya origin may have higher SBP, and that women with more fat may have an elevated SBP as well.

Among all biological characteristics lung functions as measured by certain respiratory parameters are the ones which show the greatest decline with age cohorts. In the Merida sample, for most studied respiratory measures this decline is greater in women, except ERV, MV and RR with the decline greater in men. Regression analysis shows that even though we have different individuals in each age cohort, age explains about 40 percent of the variance in VC. Height is the second variable, which explains 17 percent of the VC variance. For this reason, even though there are significant differences in living conditions between older and younger age cohorts which can change these parameters, most of observed differences in respiratory variables (most of which are highly correlated with VC) between age cohorts can be considered as age caused. Two factors have been suggested for the decrease in work efficiency of lungs with age. One decreases results from an accumulation of metabolic waste products in long-lived cells[34]. The second may be due to a decline in chest movement caused by weakening working muscles and changes in bone structure. ERV (which measures possible further residual expiration level – the amount of air which usually remains in the lungs after the normal expiration level) declines by the greatest percentage with increasing age between cohorts. In men the decrease in FEV_1 (the lung volume in 1 second of forced expiration) shows the sec- ond greatest percentage of decline between age cohorts, followed by VC (lung volume measured from a complete expiration of air following a deep inspiration), and IRV (possible farther inspiration starting from the normal inspiration level). For women, the decline in the value of IRV with age cohorts exceeds that of FEV_1. The level of decline of the Tidal Volume (TV) is the lowest, because this parameter measures the expiration and inspiration volumes during normal respiration. These results might support the hypothesis that decrease in volume measured with age is greater for more complex functions of the body which need cooperation of many organs infrequently used during the lifespan (for example forced work of the lungs[16]).

Another case concerns minute ventilation (MV) which is not correlated with VC. MV measures the volume of air expired during one minute. Differences in MV between rising age cohorts vary in men and women. In the women of Merida, MV slowly declines with the older age cohorts by 6 percent, and in the man it rises by 36 percent until the 65-year-old cohort. Data available for European populations (the Polish example[6]) have shown a slightly different pattern for men (Figure 6). Here only a small rise is observed until the 55-year-old cohort, then a decline occurs. The pattern of age cohort differences in VC is similar for both population samples. However all volumes of respiratory measures are greater in Merida. Although, if MV for VC is analyzed, the pattern of differences (a continuous rise between age cohorts) is the same for both populations, with still greater values for the Merida sample (Figure 7). Using words for aging phenomena, this example might show that even if MV decreases in women with age cohorts and increases in men and VC decreases with age in both genders, the process of respiration requires more air intake with age. The above phenomenon shows the existence of different modes of adaptation of respiratory functions between Yucatan and European populations, probably related to climate and lifestyle.

To summarize the above-mentioned findings, three phenomena should be mentioned. One this is the probable existence of a specific form of adaptation for the Yucatecan population to the local (tropical) environment, as shown by the type of MV differences between age cohorts. Next, the fact that women show a greater relationship between studied variables than men (results from regression analysis) confirms their lower sensitivity to environmental factors. The third phenomenon demonstrates differences between genders caused by economic conditions. This phenomenon may have an origin in the colonial period (19th century), where large haciendas existed in the Yucatan Peninsula. At that time the mortality rate for women was higher than that for men, because, as a physical source of labor, only men were included in the health care system provided by hacienda owners[12,35]. This fact could have worked as a selection mechanism within the cohort of women, where only the healthiest, perhaps having specific body proportions and stature could have survived. Another interesting hypothesis is, that the absence, very slow or very rapid secular trend observed in some tribes, populations or even social groups, presenting continuous improvements in living conditions, may have its origin in microevolutionary changes[36–38]. If, for example, for long term living conditions of women were worse than those of men, even within the same socioeconomic group, morphological and physiological characters which are determined by hereditary and environmental factors may have been subjected to microevolutionary changes. If this is true, there should not be any secular changes in women of this low social class at the beginning of this century. Possibly, during the last decades of this century, intensive migrations from villages to towns and considerable improvements in living conditions might have make the secular changes among women even more pronounced than among men.

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RAZLIKE MEĐU SPOLOVIMA U GRAĐI TIJELA I FIZIOLOŠKIM FUNKCIJAMA U OSOBA ODRASLE DOBI IZYUCATANA, MEKSIKO

S A Ž E T A K

Ovo istraživanje, provedeno u razdoblju 1994.–1995., procjenjuje spolne i dobne razlike u građi tijela, krvnom tlaku i respiratornoj funkciji u osoba niskog socijalnog i ekonomskog statusa koji žive u Merida, Yucatan, Meksiko. Uzorak uključuje 344 muškarca i 320 žena, dobi od 20 do 98 godina, koji je kod svakog spola podijeljen u šest dobnih skupina (20–29, 30–39, 40–49, 50–59, 60–69 te 70 i više godina). Razlike između dobnih skupina bile su izraženije u žena nego u muškaraca i to za: visinu, tjelesnu masu, debljinu, sistolički krvni tlak, kao i za većinu respiratornih varijabli (uz iznimku ekspiratornog rezidualnog volumena, minutnog volumena pluća i frekvencije disanja). Izraženiji sekularni trend za visinu tijela kao i veće biološke razlike između dobnih skupina kod žena mogu imati svoj početak u XIX. stoljeću kada su životni uvjeti bili lošiji za žene nego za muškarce. Tek od zadnjih desetljeća XX. stoljeća, migracije i poboljšanje životnih uvjeta života mogli su značiti drastičniju promjenu za žene negoli

za muškarce niskog socijalnog sloja. Rezultati regresijske analize pokazuju veću povezanost između ispitivanih varijabli u žena nego u muškaraca što potvrđuje teoriju o manjoj osjetljivosti žena na čimbenike okoliša. Uzorak promjena u minutnom volumenu (MV) u starijim dobnim skupinama razlikuje se između muškaraca i žena (manja razlika javlja se u ženskoj kohorti). Kako se ovaj uzorak (MV) razlikuje od nalaza u europskim populacijama, to upućuje na moguće postojanje nekih adaptivnih fenomena na lokalan okoliš.