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CARDIOVASCULAR RISK FACTORS IN WOMEN OF DIFFERENT AGE AND EXERCISE TRAINING STATUS

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KARDIOVASKULARNI FAKTORI RIZIKA KOD ŽENA RAZLIČITE STAROSTI I TRENAŽNOG STATUSA

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ABSTRACT

Objective. Since it has been clearly shown that the prevalence and the incidence of cardiovascular diseases increase with age, the aim of our study was to assess the potential of exercise training, as one of the of the major modifiable behavioral risk factors which greatly affects a number of physiological cardiovascular risk factors, in reducing the effects of aging on cardiovascular risk profiles in women.

Method. A group of 44 women who exercised regularly and 34 age-matched women who performed no physical activity, all of whom were aged between 21 and 60 years, were subjected to morphofunctional testing and blood sampling. Measurement of body composition was performed by using an apparatus for bioelectrical impedance analysis BC-551 InnerScan Body Composition Monitor. The participants were subjected to a maximal progressive exercise test on a treadmill Technogym Excite Jog 500 by using Bruce's protocol. Plasma lipid status (total cholesterol, high density lipoprotein, low density lipoprotein, triglycerides) was analyzed.

Results. The results of our study showed that regular exercise positively influences aerobic capacity and weight of women, but it does not alleviate the influence of aging on majority of morfo-functional and physiological risk factors (the increase of total cholesterol, low density lipoprotein, triglycerides, body mass index, visceral fat and decrease of aerobic capacity with age). After the age of 40 and especially after the age of 50, women experience significant rise of cardiovascular risk factors no matter if they exercise or not.

Conclusion. The results of this cross sectional research showed that there is no significantly positive effect of exercise on cardiovascular risk profile of aging women.

Keywords: *exercise; risk factors; cardiovascular diseases; lipoproteins; women.*

SAŽETAK

Cilj. Obziom da su prethodna istraživanja jasno pokazala da prevalenca i incidenca kardiovaskularnih oboljenja raste sa starenjem, cilj našeg rada bio je da utvrdimo potencijal redovnog vežbanja, kao jednog od najvećih modifikujućih bihevioralnih faktora rizika koji značajno utiče na niz fizioloških kardiovaskularnih faktora rizika, u ublažavanju efekata starenja na kardiovaskularni risk-profil žena.

Metod. Grupa od 44 žene koje redovno vežbaju i 34 sedentarne žene sličnog godišta, sve u životnom dobi od 21 do 60 godina, podvrgnute su morfofunkcionalnom testiranju i uzimanju uzorka krvi. Merenje telesne kompozicije je urađeno korišćenjem aparata za analizu bioelektrične impedanse “BC-551 InnerScan Body Composition Monitor“. Učesnici su bili podvrgnuti testu maksimalnog progresivnog vežbanja na traci “Technogym Excite Jog 500“ koristeći protokol po Brusu. Analiziran je lipidni status (ukupni holesterol, lipoproteini visoke gustine, lipoproteini niske gustine, trigliceridi) u plazmi.

Rezultati. Rezultati studije su pokazali da redovno vežbanje ima pozitivan uticaj na aerobni kapacitet i telesnu masu žena, ali ne može sprečiti uticaj starenja na većinu morfofunkcionalnih i fizioloških kardiovaskularnih faktora rizika (povećanje nivoa ukupnog holesterola, lipoproteina male gustine, triglicerida, visceralne masti, indeksa telesne mase i smanjenje aerobnog kapaciteta). Vežbale ili ne, nakon 40-te i posebno 50-te godine, žene doživljavaju značajno pogoršanje svog kardiovaskularnog risk-profila.

Zaključak. Rezultati ove studije preseka su pokazali da ne postoji statistički značajan pozitivan efekat fizičke aktivnosti na kardiovaskularni rizik profil žena starijeg životnog doba.

Ključne reči: *vežbanje; faktori rizika; kardiovaskularne bolesti; lipoproteini; žene.*

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INTRODUCTION

Cardiovascular diseases (CVD), a group of disorders of the heart and blood vessels, represent the major cause of death of both men and women throughout the world. About 55% of all female deaths and about 43% of male deaths in Europe are caused by CVD (1). Advances in our understanding of the pathophysiology of cardiovascular diseases have led to a reduction in CVDs and related diseases, but to date cardiovascular illnesses remain among the leading causes of morbidity and mortality in the world. Genetic factors and age are proven risks but other factors, such as hypertension, insulin resistance, hypercholesterolemia, diabetes, and lifestyle factors (e.g. poor diet, smoking and physical inactivity) are also important (2).

Regular physical activity undoubtedly has numerous health-enhancing effects. From the early work of Morris and colleagues in the 1950s (3, 4), via the investigations of Blair, Paffenbarger and colleagues in 1980s and 1990s (5-8) until today, numerous studies have shown a positive correlation between physical activity, physical fitness and the relative risk of a number of diseases and early death (9-14). These findings and results of the studies that showed biologically reasonable cardioprotective pathways provided the evidence that regular physical activity reduces the incidence of major CVD events, pointing to the physical inactivity as a major CVD risk (2). Nevertheless, the Norwegian epidemiologist Gunnar Erikssen asserts that “modern day humans are dying because of a lack of physical exercise” (15).

Since the results of studies showed that the CVDs increased with age (16), and having in mind that physical activity represents one of the major modifiable behavioral risk factors which greatly affects a number of physiological CVD risk factors and improves overall CVD risk profile, the aim of our study was to assess the potential of exercise training in reducing the effects of aging on cardiovascular risk profiles in women.

SUBJECTS AND METHODS

A group of 44 female members of “Elit” fitness club (Kragujevac) who exercised regularly (experimental group) and 34 age-matched women who performed no physical activity (control group) took part in this research. All members of the experimental group had been performing a mix of aerobic and strength training 3-5 times a week for more than 3 months in continuity before the beginning of the study (average duration of regular exercising: 16.74±2.86 months). Secondly, subjects were classified into 4 groups according to their age (women who were 20-30, 30-40, 40-50 and 50-60 years old). Seven out of thirteen oldest women were in menopause.

All subjects were healthy, non-smokers, had no eating disorders and used no medication or supplementation. They were instructed to abstain from any physical activity 24 hours prior to testing and received the same diet 48 hours prior to testing. All participants gave a written informed consent. The study was approved by the Ethical Committee of the Medical Faculty, University of Kragujevac.

The research protocol started at 7 AM. After the participants had filled in the standard medicine questionnaire, their blood pressure was measured and they were taken a blood sample from an antecubital vein. Then, measurement of body composition was performed by using an apparatus for bioelectrical impedance analysis BC-551 InnerScan Body Composition Monitor (Tanita, Japan). Measurement was performed according to the manufacturer’s instructions. Body weight was measured with the accuracy within 0.1 kg and body fat with the accuracy of 0.1 %. Body height was measured by means of an anthropometer and the results of the measurements were accurate within 0.1 cm.

After the anthropometrical measurement and blood sampling, the subjects had light and lean breakfast and after an hour of rest they were subjected to a maximal progressive exercise test on a treadmill Technogym Excite Jog 500 (Technogym, Italy) by using Bruce’s protocol (17). Subjects were familiarized to testing procedure. The exercise test was performed until exhaustion or until the moment when subjects stated their subjective feeling of exhaustion by using Borg’s CR10 exhaustion scale of at least 8 (18). Maximal oxygen consumption (VO2max) was determined by an indirect method by using the following equation (19): VO2max = 2.327 (time) + 9.48.

Blood samples were taken from an antecubital vein into Vacutainer test tube. After transportation of the samples to the laboratory (in a fridge), blood was centrifuged to separate sera and red blood cells (RBCs) and plasma lipid status (total cholesterol, high density lipoprotein, low density lipoprotein, triglycerides) was analyzed by using routine laboratory protocols in the Central Biochemical Laboratory of Clinical Centre Kragujevac.

The statistical analysis was performed with SPSS 19.0 for Windows. The results are expressed as means ± standard error of the mean (median). The significance of the influence of the training status and age and combination of these factors (training status*age) was assessed by using Two-way ANOVA and Bonferroni post hoc test. The significance level was set at $P<0.05$.

RESULTS

Levels of cardiovascular risk factors in subjects who do and do not exercise are shown in table 1, while levels of these parameters in subjects of different age are shown in table 2.

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Table 1. Cardiovascular risk factors in controls and subjects who exercise.

Parameter*	Controls (n=34)	Exercisers (n=44)
Age (years)	35.73±1.57 (35.00)	34.59±1.82 (35.00)
Height (cm)	170.25±1.38 (170.00)	169.73±1.15 (168.00)
Weight (kg)	68.03±2.13 (65.35)	64.42±1.98 (65.35)
BMI (kg/m^2)	23.56±0.62 (22.58)	22.22±0.62 (21.95)
Fat (%)	25.45±1.27 (23.85)	23.54±1.77 (23.10)
Visceral fat (%)	4.17±0.61 (2.50)	3.15±0.39 (3.50)
VO_2max (ml/kg/min)	33.60±0.71 (33.30)	37.89±0.68 (38.21)
Systolic pressure (mmHg)	119.69±2.02 (119.00)	124.24±2.55 (124.00)
Diastolic pressure (mmHg)	77.81±1.54 (78.00)	80.44±1.98 (80.00)
Total cholesterol (mmol/l)	5.39±0.16 (5.10)	5.02±0.23 (4.82)
HDL (mmol/l)	1.30±0.03 (1.30)	1.41±0.05 (1.40)
LDL (mmol/l)	3.63±0.14 (3.32)	3.15±0.23 (2.95)
Triglycerides (mmol/l)	1.01±0.06 (0.89)	1.01±0.06 (1.01)

*X±SE(median)

Table 2. Cardiovascular risk factors subjects of different age.

Parameter*	21-30 years (n=27)	31-40 years (n=21)	41-50 years (n=17)	51-60 years (n=13)
Height (cm)	171.30±1.36 (169.00)	170.64±2.22 (171.00)	168.66±1.16 (168.00)	167.11±2.08 (165.00)
Weight (kg)	63.83±1.99 (63.50)	65.95±3.45 (64.05)	66.52±3.03 (67.15)	74.71±3.93 (69.70)
BMI (kg/m^2)	21.71±0.54 (21.72)	22.58±0.95 (22.11)	23.33±0.93 (23.10)	26.64±0.90 (26.23)
Fat (%)	24.64±1.49 (22.55)	22.25±2.13 (23.05)	22.44±2.07 (20.25)	33.02±1.41 (34.60)
Visceral fat (%)	1.95±0.29 (1.50)	2.92±0.43 (2.50)	5.00±0.69 (5.50)	8.00±1.33 (7.00)
VO_2max (ml/kg/min)	37.06±0.68 (38.21)	36.15±0.87 (36.84)	33.83±1.21 (31.36)	28.46±1.85 (26.80)
Systolic pressure (mmHg)	122.22±2.36 (121.00)	116.33±3.53 (116.00)	122.52±2.36 (121.00)	129.80±5.67 (124.00)
Diastolic pressure (mmHg)	79.85±1.97 (78.00)	75.04±2.51 (75.00)	79.11±2.45 (79.00)	84.20±2.82 (83.00)
Total cholesterol (mmol/l)	4.83±0.19 (4.60)	5.15±0.22 (5.01)	5.41±0.27 (5.16)	6.37±0.35 (6.37)
HDL (mmol/l)	1.34±0.03 (1.31)	1.41±0.06 (1.35)	1.25±0.05 (1.27)	1.29±0.08 (1.32)
LDL (mmol/l)	3.10±0.17 (2.95)	3.29±0.22 (2.98)	3.71±0.24 (3.54)	4.36±0.30 (4.25)
Triglycerides (mmol/l)	0.85±0.06 (0.75)	0.99±0.08 (0.92)	1.00±0.07 (1.01)	1.57±0.10 (1.58)

*X±SE(median)

The influence of age, training status and combination of these factors on levels of cardiovascular risk factors investigated in this research was assessed by Two-way ANOVA and the results of this analysis are shown in Table 3. It can be noticed from the table 3 that training status (exercising or not) influences only two parameters – weight and aerobic capacity of subjects (subjects who exercise have lower weight and higher aerobic capacity), while age influences 6 investigated parameters – body mass index, visceral fat, aerobic capacity, total cholesterol, LDL and triglycerides. Post hoc analysis (Bonferroni) showed that:

- Weight increased with aging, but statistically significant difference was found only between subjects who were 51-60 years old and subjects who were 21-30 years old (P=0.042);
- Body mass index increased with aging, but statistically significant differences were found only between

*Table 3. The influence of training status, age and combination of these factors (training status*age) on levels of cardiovascular risk factors.*

Parameter	Training status	Age	Training status Age
Height	P=0.719	P=0.354	P=0.310
Weight	P=0.031	P=0.397	P=0.236
BMI	P=0.075	P=0.035	P=0.247
Fat percentage	P=0.086	P=0.075	P=0.090
Visceral fat	P=0.100	P<0.001	P=0.142
VO_2max	P<0.001	P<0.001	P=0.199
Systolic pressure	P=0.325	P=0.139	P=0.567
Diastolic pressure	P=0.629	P=0.167	P=0.231
Total cholesterol	P=0.175	P=0.018	P=0.454
HDL	P=0.229	P=0.214	P=0.800
LDL	P=0.134	P=0.024	P=0.326
Triglycerides	P=0.702	P=0.004	P=0.515

subjects who were 50-60 years old and: 1) subjects who were 21-30 years old (P=0.001), 2) subjects who were 31-40 years old (P=0.013);

- Visceral fat percentage increased with aging and following statistically significant differences were found: 1) the oldest subjects (50-60 years old) had higher levels of visceral fat than all other groups of younger subjects (50-60 vs 21-30: P<0.001; 50-60 vs 31-40: P<0.001; 50-60 vs 40-50: P=0.005), 2) levels of visceral fat were increased in subjects 41-50 years old compared to subjects 21-30 years old (P<0.001)
- Aerobic capacity decreased with age and statistically significant differences were found between: 1) 20-30 years old and 41-50 years old subjects (P=0.037), 2) 21-30 years old and 50-60 years old subjects (P<0.001), 3) 31-40 years old and 50-60 years old subjects (P<0.001), 4) 41-50 years old vs 50-60 years old subjects (P=0.008);
- Levels of total cholesterol increased with ageing and statistically significant difference was found between the oldest subjects (50-60 years old) and 1) subjects who were 21-30 years old (P<0.001), 2) subjects who were 31-40 years old (P=0.004), 3) subjects who were 41-50 years old (P=0.023);
- Levels of low density lipoprotein increased with age and statistically significant difference was found between the oldest subjects (50-60 years old) and 1) subjects who were 21-30 years old (P=0.001), 2) subjects who were 31-40 years old (P=0.009);
- Levels of triglycerides increased with age and statistically significant difference was found between the oldest subjects (50-60 years old) and 1) subjects who were 21-30 years old (P<0.001), 2) subjects who were 31-40 years old (P=0.003), 3) subjects who were 41-50 years old (P=0.002).

The combination of investigated factors (training status*age) showed no significant influence on any of investigated cardiovascular risk factors (Table 3).

DISCUSSION

CVD risk factors can be classified as major, conditional and predisposing risk factors. The independent risk factors for CVD are hypertension, smoking, elevated total serum cholesterol and low-density lipoprotein cholesterol (LDL), low serum high-density lipoprotein cholesterol (HDL), diabetes mellitus, and older age (19). The additional risks, associated with increased risk for CVD, but without proven independent casual relationships are: obesity, physical inactivity, family history of premature CVD, ethnic background and psychosocial issues (19). Elevated serum triglycerides, elevated serum homocysteine, elevated serum lipoprotein, prothrombotic factors and inflammatory markers are considered as the predisposing risk factors (19).

Many consider physical inactivity to be one of the major environmental factors that increase the incidence of cardiovascular diseases (20). The exact magnitude of the effect of inadequate physical inactivity in cardiovascular risk profile is still uncertain. Epidemiological studies have shown that the relative risk of developing CVD and subsequent mortality is 30-50 % lower in physically active and physically fit persons compared with sedentary individuals (21, 22), which is addressed to the positive effects of exercise on all above-mentioned cardiovascular risk factors (23-27).

Having in mind all the above mentioned, we tried to explore the cardiovascular risk profile of women of different age and training status. Although Table 1 shows that there are differences between controls and exercisers in majority of investigated parameters, statistical analysis showed that physical activity significantly affected only two investigated parameters: weight and aerobic capacity. On the other side, 6 investigated parameters were affected by age (body mass index, visceral fat, aerobic capacity, total cholesterol, LDL and triglycerides).

Older age is a significant risk factor for both males and females. However women develop CVD much later (about a decade) than their male counterparts (16). Women have a lower risk of cardiac events during the fertile age but this protection fades in later life. At the age of 45–54 years (menopause) women with untreated risk factors are at increased risk for CVD (1). In addition, the age influences the risk-profile differences between men and women. Total cholesterol levels in women peak between 55 and 65 years of age, about a decade later than in men (29). The results of our research are in accordance with this, since post hoc analysis showed that the only statistically significant difference in cholesterol levels was seen between the groups of women aged 50-60 and all other groups of younger women. This was also the case for triglycerides. Obesity appears more often in younger men (younger than 45 years) and in older women (older than 45 years) (30). In our research the oldest women had higher body mass indexes compared to women in twenties and thirties, while levels of visceral fat started to be elevated in women older than 40.

The most important finding of our study is that although physical activity positively affected subjects' body weight and cardiorespiratory fitness, it could not prevent the effects of aging and hormone changes on a number of CVD risk factors. After the age of 40 and especially after the age of 50, women experienced significant rise of cardiovascular risk factors no matter if they exercised or not.

The results of this cross sectional research show that there is no significantly positive effect of exercise on cardiovascular risk profile of aging women. The limitation of our study relates to the knowledge about severity of exercise trainings of these women, since there are no written documents about their exercise programs in the fitness centre, but only the data about their regularity on trainings. Prospective design of the study in the controlled conditions would help in achieving the aim of our study more securely. For example, regular programmed exercise can prevent or delay adverse cardiovascular events in postmenopausal women. Further investigations of our research team may support this hypothesis.

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