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THE BIOLOGICAL AGE OF 60–91 YEAR OLD SLOVAK WOMEN

ABSTRACT: The goal of this study was to assess the biological age of postmenopausal Slovak women. The study group consisted of 188 women aged of 60–91 years. The analysis included biochemical, anthropometrical, bioimpedance, social and health characteristics and also life style characteristics. The Borkan and Norris (1980a,b) method was used for biological age assessment. According to this, biological age was computed as a composite z-score. The results show that women living in retirement homes generally seem to be biologically older than their in household-independently living contemporaries. Women without depression and without other negative mental conditions also appear to be biologically younger. This study indicates that knowledge about the biological status of individuals and the analysis of associated factors may, in terms of preventive measures, help to improve the overall health and quality of life of the population.

KEY WORDS: Adult women – Biological age – Social environment – Mental status – Life style

INTRODUCTION

Aging is a spontaneous and programmed process which corresponds with physiological and pathological processes of an organism. These processes gradually alter the structure and functions of the organism. In other words, old age comes when the various cell and tissue elements can no longer completely perform their biological roles (Massa *et al.* 2008). Health status among older individuals shows tremendous variation. The rate of the human aging variability represents an important and active part of basic and clinical gerontological research (Karasik *et al.* 2004).

Biological age is often understood quantitatively as "the real overall state" of an aging organism, and it is much more correct than corresponding chronological age (Klemera, Doubal 2006). Individual biological age shows a stronger correlation to mortality than chronological age (Mitnitski *et al.* 2002). Biological age can be calculated for any given age group and it can be applied in randomly individuals from the total population. People with a poorer functional status of their organism are considered "biologically older" than their chronological contemporaries and on the contrary,

people who's functional status is better might be considered "biologically younger" (Karasik *et al.* 2005). Assessment of biological age is based on the selection of biomarkers (on age-dependent variables) and on the selection of statistical methods (Klemera, Doubal 2006). A biomarker of aging is a biological parameter of an organism that either alone or in some multivariate composite will better predict functional capability at late age than chronological age (Baker, Sprott 1988). The methods used in the assessment of biological age include a number of parameters corresponding with chronological age (biochemical, physical, mental and many others) (Borkan, Norris 1980a, b, Karasik *et al.* 2004, Kaczmarek, Lasik 2006).

As mentioned above, the aging process represents a progressive cumulation of alterations responsible for the ever-increasing predisposition to diseases and death, associated with advancing age (Harman 1981). Heart disease, cancer and stroke are the three main causes of death for women of age 65 years and older. Arthritis and hypertension are the two main chronic conditions that affect older people. Women are more likely to have two or more chronic conditions than men (Rice 2000). Elderly women's health problems affect their everyday life – their

ability to perform social activities, their relationships with family and friends, their future plans and also their general psychological well-being, whereby attitude towards oneself is important (Heidrich 1996). Many studies about older/old women's health and aging shows that loss of muscle mass and greater fat infiltration in muscles may contribute to poor physical performance and consequent disability in older age (Visser *et al.* 2002). The following recommendations among others are important from the point of view of promotion of healthy aging: hormone replacement therapy, weight monitoring, enhanced intake of fruit and vegetables, a low fat diet and physical activities (La Croix *et al.* 1997).

SUBJECTS AND METHODS

This study is a follow-up of the paper of the Lajdová *et al.* (2008) study which focused on Slovak seniors living in two different social environments. All data was collected from 60–91 years old seniors, living in two different social environments (households/retirement home). All participants were volunteers. Research, in various regions in Slovakia, was realized by the members of Department of Anthropology, Comenius University, Bratislava, in cooperation with the general practitioners who provided the informations about the proband's health status. Various characteristics have been identified (health, social, emotional, biochemical, anthropometrical parameters, body composition and lifestyle characteristics). The basic anthropometric measurements were set according to Knussmann (1988). Body composition was evaluated using a BIA 101 analyser (Akern S.r.l.). BIA (bioelectrical impedance analysis) for determination of body composition works on a principle of the body's resistance to electical flow with low intensity (800μA) and high frequency (50 kHz). From two measurements – resistance (Rz) and reactance (Xc) – detailed body composition variables are obtained, using the Bodygram program.

All subjects were without any mental impairment, with independent mobility and ablty to manage their everyday activities alone.

In this research focused on the association of social, health related and habitual characteristics of Slovak seniors living at home and institutionalised many differences in these parameters were found between older women living in two different social environments. The results showed that institutionalised females have higher systolic and diastolic blood pressure levels than their contemporaries living in their own households. Many negative answers concerning socio-emotional questions were recorded from institutionalised females. Overall, it was found that institutions (retirement homes) represent a stressful environment for seniors (Lajdová *et al.* 2008).

For biological age assessment the following 19 biomarkers (positively or negatively linearly correlating with chronological age of probands) were used:

Anthropometric measures and parameters: body height (cm), body weight (kg), hip-circumference (cm) and conicity index-CI.

Bioelectrical impedance analysis: muscle mass (kg), fat mass (kg), fat free mass (kg), body cell mass (kg), body mass index-BMI, body cell mass index-BCMI, basal metabolic rate-BMR (kcal), intracellular water (l), extracellular water (%), total body water (l), reactance (ohm), sodium/potassium ratio.

Biochemical blood analysis: HDL cholesterol, creatinine, uric acid.

A deeper analysis was performed according to different social environment (households/retirement home), alcohol intake (consumption/non-consumption of alcohol), depression incidence (yes/no), and anxiety status (anxious /non-anxious women).

Biological age (BA) was computed using the Borkan and Norris method (1980a,b). According to this, BA was computed as a composite z-score. The first step was calculation of individual z-score for a single variable. Then, these individual z-score were converted to a BA score by this four-step transforming procedure:

1) Simple linear regression of each variable on age.
2) Subtraction of the predicted score from the actual score of each individual.
3) Standardisation of residual scores using the z-transformation.
4) Conversion of data (negative sloped variables were multiplied by –1 to facilitate interpretation).

The result is the transformation of 19 age-related variable data into 19 biological age scores. These scores reflect the real biological/physical status of studied women, in comparison with their chronological contemporaries.

Profiles of BA were plotted on a chart (subgroups were plotted by their mean scores of the 19 variables). On abscissa positive or negative values of biological age are shown and the ordinate shows the 19 variables studied. Analysis the pairs of means included the Mann-Whitney test. Negative values of biological age reflect biologically younger women and the contrary, positive values refer to biologically older women. For a statistical data processing the statistical program SPSS, version 11 was used.

RESULTS

The study group included 188 women in age from 60 to 91 years. The mean age of these women was 72, 86 years (±6.956 years). *Table 1* shows 19 monitored variables. From the group, 80 women (42,55%) were living in households (alone or with family) and 108 women (57,45%) were living in retirement homes. 67% of studied women occasionally consumed alcohol, 35,5% of women had the feeling of fear and anxiety and 47,9% of studied women suffered from depression.

TABLE 1. Selected characteristics of 60–91 year old women studied (N 188).

Variable	Mean	SD
Age (years)	72.8	6.956
Body height (cm)	154.785	7.0558
Body weight (kg)	71.151	13.8123
Hip-circumference (cm)	109.853	10.8227
Conicity index	1.303444	0.093777
Muscle mass (kg)	28.598	7.6247
Fat mass (kg)	29.179	9.5044
Fat free mass (kg)	42.105	5.3479
Body cell mass (kg)	22.981	6.8075
Body mass index	29.579	5.1154
Body cell mass index	9.444	2.9600
Basal metabolic rate (kcal)	1163.243	241.7791
Intracellular water (l)	17.094	3.2153
Extracellular water (%)	49.335	6.2808
Total body water (l)	33.640	4.3633
Reactance (ohm)	50.0	13.867
Sodium/potassium ratio	1.035	0.2048
HDL cholesterol	1.2785	0.37237
Creatinine	82.55787	19.13229
Uric acid	316.52420	99.36169

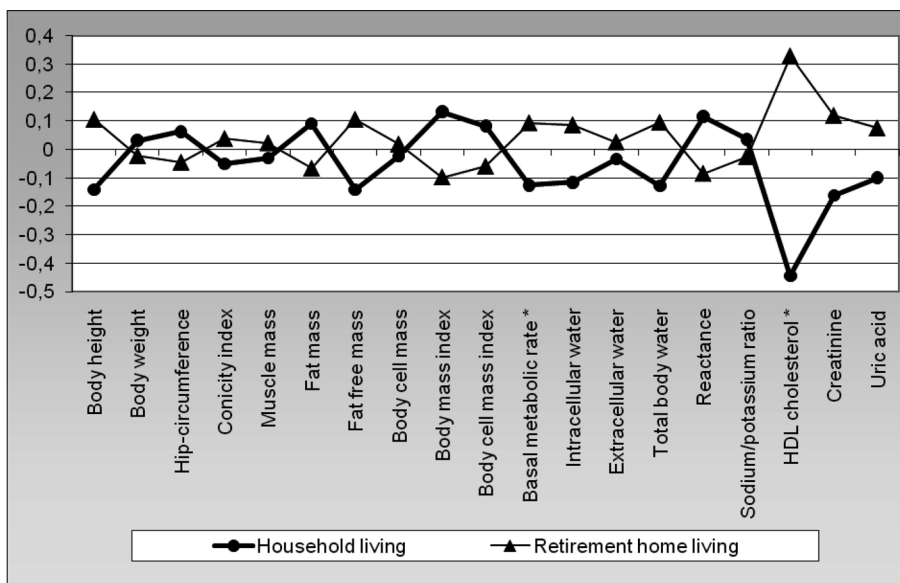|	N	%
Women living in households	80	42.55
Women from retirement homes	108	57.45
Women with occasional alcohol intake	126	67.00
Women without alcohol intake	62	33.00
Anxious women	66	35.50
Non-anxious women	120	64.50
Women suffering from bouts of depression	89	47.90
Women without depression	97	52.20

FIGURE 1. Profiles of women's biological age by different social environment (*statistically significant differences, Mann-Whitney test).
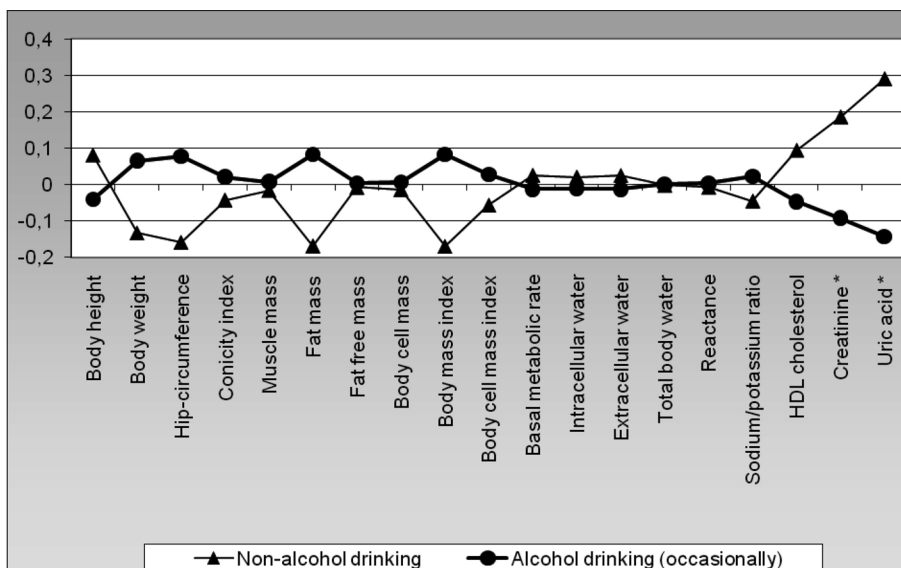
FIGURE 2. Profiles of women's biological age by alcohol consumption (*statistically significant differences, Mann-Whitney test).
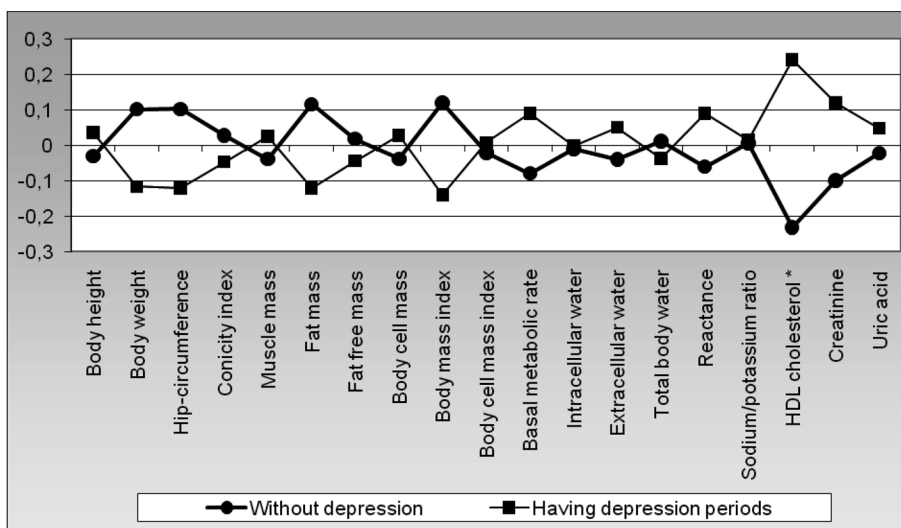

FIGURE 3. Profiles of women's biological age by depression status (*statistically significant differences, Mann-Whitney test).
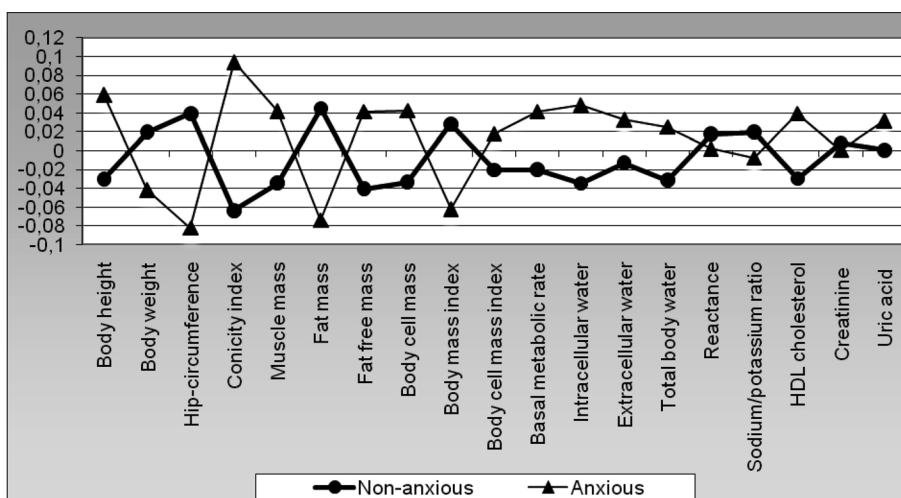

FIGURE 4. Profiles of women's biological age by anxiety status (*statistically significant differences, Mann-Whitney test).

Profiles of biological age according to social environment are shown in *Figure 1*. Overall, it can be said, that as expected, women living in households seem to be biologically younger than their contemporaries living in retirement homes. Statistically significant differences between women living in households and women living in retirement homes were found in basal metabolic rate (p=0,016) and in HDL cholesterol level (p<0,001). Women living in households were according to given parameters significantly younger.

Figure 2 shows the profiles of women's biological age in relation to alcohol intake. As it is seen, alcohol drinking was not markedly associated with biological status. However, women, drinking alcohol occasionally, are significantly younger in two parameters: creatinine level (p=0,025) and uric acid level (p=0,006).

Profiles of women's biological age by depression status are displayed on *Figure 3*. Women without depression periods seem to be much more biologically younger than same aged women suffering from depression. By comparison of these subgroups a statistically significant difference in HDL cholesterol level (p=0,001) was noticed. Non-depressive women were in relation to this parameter significantly biologically younger.

As shows *Figure 4*, similarly to women without depression, in most of all parameters non-anxious women are biologically younger than their contemporaries with (occasional) anxiety events. However, a statistically significant difference between these two subgroups in selected parameters was not observed.

DISCUSSION

The results of our study indicate a generally lower biological age of old Slovak women living in households. Better biological status of these women in comparison with women from retirement homes can be widely expected. Retirement homes can present a much more negative social environment where seniors are mostly dependent on nursing care, they are less physically active even immobile, without family contact (or a weaker contact with relatives). The socio-economic status is mostly at lower level, too. All this may deteriorate the senior's life quality, health and aging what can be reflected in a negative biological status of these subjects. Hence, living in households represents a better environment for aging people (Lajdová *et al.* 2008, Rioux 2005). Lower socioeconomic level of older people is associated with higher risk of depression and loneliness, risk of functional limitations and earlier mortality, compared with older adults with higher socioeconomic status (Broese van Groenou 2003). According to a study by authors Hauser and Neumann (2005), positive aging and quality of life of 59–92 years old individuals from Vienna and surroundings were related to family contact, positive attitude towards life and physical activity.

Women living in households were significantly biological younger in HDL (high-density lipoprotein) cholesterol and basal metabolic rate. HDL cholesterol concentration remained unchanged with age, but the susceptibility of HDL to oxidation process increases with aging (Seres *et al.* 2004). Many scientific studies demonstrate that the low HDL cholesterol level is an important risk factor for coronary artery diseases, stroke and mortality in old age (Clee *et al.* 2000, Weverling-Rijnsburger *et al.* 2003, Arai, Hirose 2004). The Japan scientific study (Nakamura *et al.* 1990) of women aged to 64 years shows that lipid metabolism might play an importatnt role not only in the determination of serious vascular diseases but also in determination of the rate of women's biological aging. Hence, in general we can say that HDL cholesterol might be a good, reliable indicator for biological aging/biological status of an organism.

Basal metabolic rate represents a factor determining the rate of aging within individual mammalian species (Greenberg, Wei 2000). As the human organism ages, the skeletal mass decreases. A decrease in skeletal muscle mass may be principally responsible for the age-related decrease in basal metabolic rate (Tzankoff, Norris 1977). Energy output and energy need generally decreases with advancing age. This is caused by a decrease in basal metabolic rate and physical activity (Pannemans, Westerterp 1995). Thus, ageing in the elderly is characterised by a loss of fat-free mass and reduction in basal metabolic rate. A study by British scientists (Murray *et al.* 1996) showed that physically active elderly individuals (men about 60 years) in a good health status show very small age-related declines in basal metabolic rate and fat-free mass. As already mentioned, seniors from retirement homes are mostly physically less active than seniors living in households and this might explain our finding that women living in households are in basal metabolic rate (and fet-free mass too) biologically younger than women from retirement homes.

This study did not show an unequivocal relationship between alcohol drinking and biological age of studied women. Our results correspond with the findings of a Polish study of Kaczmarek and Lasik (2006). In 400 postmenopausal women also only a weak association between alcohol intake and biological age was found (in certain parameters women drinking alcohol were biologically younger than non-drinking women). Our analysis has shown that women with occassional controlled alcohol intake were biologically younger as regards to serum creatinine and uric acid level, compared with their non-drinking contemporaries.

Uric acid belongs to biomarkers reflecting oxidative stress rate in the course of the aging process and its consequences on cell metabolism (Voss, Siems 2006). Elevated serum uric acid level is associated with increased risk for renal disease (Johnson *et al.* 2003), diabetes (Dehghan *et al.* 2008), acute ischaemic stroke (Milionis *et al.* 2005), hypertension (Fang, Alderman 2000, Johnson *et al.* 2003) and myocardial infarction (Bos *et al.* 2006). Hence, increased serum uric acid levels are independently and significantly associated with the risk of cardiovascular mortality and the mean levels of serum uric acid increase with age. Among women this relationship

between increased uric acid levels and cardiovascular mortality (otherwise independent of menopausal and cardiovascular risk status) is stronger than among men (Fang, Alderman 2000). The relationship between alcohol intake and serum uric acid level has not been exactly defined yet. Studies exist that indicat higher uric acid level in relation to alcohol consumption (Fang, Alderman 2000), while other studies demonstrate no relationship between uric acid level and alcohol drinking (Hu *et al.* 2001, Viazzi *et al.* 2005). Choi and Curhan (2004) who studied the effect of individual alcohol drinks on uric acid levels on a sample of 14 809 subjects revealed substantial differences among them: for example, beer increases the uric acid level more than spirits, whereas moderate wine drinking has no effect on serum uric acid levels.

Serum uric acid level is associated with serum creatinine level (Fang, Alderman 2000). Mean serum creatinine levels increase with age both in women and men (Jones *et al.* 1998). Normal aging of an organism is associated with alterations in renal structure and function as well as in creatinine metabolism that also influences the serum creatinine concentration. Because of the decline in the glomerular filtration rate in older subjects, renal creatinine clearance also decreases. Normal aging process is also characterized by a decline in renal creatinine excretion. It can be caused by the decrease of creatinine production because of the muscle mass reduction or meat intake reduction (Perrone *et al.* 1992). Elevated serum creatinine concentration is a very potent independent risk factor for mortality (Shulman *et al.* 1989). A high serum creatinine concentration within the normal range is a marker for increased risk of cerebrovascular diseases in normotensive and hypertensive subjects and subtle impairment of renal function is a risk factor for stroke (Wannamethee *et al.* 1997). The reduction of renal and hepatic function occurs even in "healthy aging persons", just because of the increased proportion of body fat at the expense of skeletal muscle, which together with reduced drug clearance in an organism can result in marked elevation of drug serum concentrations (Avorn, Gurwitz 1995). A canadian study of 11 000 subjects from long-term care facilities, aged 65 years and more, came to the conculsion that mild and moderate renal impairment (defined as an estimated creatinine clearance) are common in seniors and increase with age (Papaioannou *et al.* 2001). Age associated decrease of renal function (reduced creatinine clearance) in elderly women is a significant risk factor for falls (in normal aging population) (Gallagher *et al.* 2007). Schaeffner *et al.* (2005) during a 14- years research on a sample of 11 023 healthy men aged from 45 years and older came to conclusion that moderate alcohol consumption is not associated with an increased risk of renal dysfunction, on the contrary, they confirmed an inverse relatioship between them.

There are many scientific studies which demonstrate the positive effect of alcohol on individual systems of human body. For example, Milon *et al.* (1982) observed in 723 French men that controlled alcohol intake (along with controlled salt intake and adiposity) may be a preventive measure for essential hypertension. Bryson *et al.* (2006) confirmed the likelihood that moderate alcohol consumption in older adults (65 years old and older) possess no cardiotoxic effect, on the contrary, moderate controlled alcohol intake is associated with a lower risk of congestive heart failure incidence. Furthermore, Rapuri *et al.* (2000) found that moderate alcohol drinking in postmenopausal elderly women (from 65 to 77 years) is associated with higher bone mineral density (the protective effect of alcohol contributes to a lower bone remodeling). Generally, moderate and controlled alcohol intake could be a part of a global health strategy (Chung *et al.* 2005) and it would also provide a means to achieve lower biological age.

It is well established that depressive and anxiety disorders reflect negatively in physical status of an organism, and thus in functional status too. Our analysis showed that women without depression periods (similarly non-anxious women) generally were biologically younger than same-aged women with depressions. A statistically significant difference between these two subgroups was observed in HDL cholesterol level. Women not suffering from depression were in the given biomarker significantly biologically younger. The relationship between the low serum cholesterol level (as well as the level of HDL cholesterol) and depression has not been clearly scientifically demonstrated yet. Maes *et al.* (1997) found that lower serum HDL cholesterol level is a marker for major depression and suicidal behaviour. However, there is also evidence to suggest no link between depression and low serum cholesterol (HDL cholesterol) level in older people (Ergün *et al.* 2004). Further studies are needed to verify this relationship.

Current trend in human sciences is represented by the effort to slow down overall aging process (and age-associated degenerative changes of an organism). Aging studies in recent years increasingly focus attention on biological age assessment. Analysis of genetic/biological and environmental factors influencing the individual's biological status is a prerequisite to ensure "healthly aging" for the present as well as for future generations. Knowledge about biological age and analysis of factors associated with lower biological age could help improve quality of life in older age.

In conclusion, our results show that a negative social environment, such as a retirement home, may be associated with older biological age. Similarly, negative mental status such as anxiety and depression may negatively influence biological age. Life style habits including occasional controlled alcohol intake seem to be less associated with biological age, but in some parameters there is a link with lower biological age.

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