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Original research article

HEALTH RELATED PHYSICAL FITNESS LEVELS OF THE ELDERLY

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Zoran Đokić[1], Dejan Jovanović[1], Miran Kondrič[2]

[1]Faculty of Sport and Tourism, University of EDUCONS, Novi Sad, Serbia
[2]Faculty of Sport, University of Ljubljana, Ljubljana, Slovenia

Abstract. *This study was designed to investigate the level of health-related physical fitness (HRPF) in the Novi Sad elderly. Forty-nine elderly people 73.22±5.04 years of age (20 females and 29 males) participated in this study. Their health status, body composition and HRPF were measured. The differences between the HRPF indicators between health risk factor groups were calculated using the one-way univariate analysis of variance (ANOVA), with a 95% confidence level (p < .05). The relationship between the health risk stratification factor and HRPF was assessed by Pearson's correlation coefficients (p < .05). Based on the Risk Factor Stratification, the participants were grouped into: a low risk - 36.7%; moderate risk – 16.3% and high risk group - 46.9% of he participants. A statistically significant difference was noted in the hand grip strength between low risk and high risk participants (p = 0.04). A moderate negative relationship between the health risk factor and balance (r = –.417) and cardiovascular fitness (r = –.426) was noted. The analyses of the health status indicate prehypertension. The results of body composition show obesity, and the HRPF level indicates a high risk of cardiovascular disease, muscle strength at risk level, and flexibility and balance at a satisfactory level for this age.*

Key words: *cardiovascular fitness, strength, flexibility, balance.*

INTRODUCTION

Interest in sport activities has grown in recent years because of the increase in leisure time as well as the belief that general health can be enhanced by improved physical fitness. For a variety of reasons, participation in physical activity declines with advancing age and current aging trends worldwide are unprecedented in human history. According to the U.S. Census Bureau, International Data Base (2008), people older than 65 accounted for 14.5 % of the total Eastern Europe population, with an expected rise in the

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Corresponding author: Zoran Đokić
Faculty of Sport and Tourism, University of EDUCONS, Novi Sad, Serbia. St. Radnička 30a, 21000 Novi Sad
Phone: +381 (0) 21 530 633 • E-mail: djokicz@eunet.rs

demographics of up to 17.3 % by 2020 (Kinsella & Wan, 2009). The Serbian population is among the oldest populations in the region, with over 1/6 of the population (1.250000 citizens) over 65 years old (Rasevic & Nikitovic, 2012), with a 74.0 and 76.34 years life expectancy at birth for males and females, respectively (UN, 2011). The impact of the aging society is substantial in many sectors, but it is likely most evident in healthcare costs (Palacios, 2002). The treatment of chronic diseases accounts for approximately 50% of global health care costs, and the ongoing lengthening of life expectancy further ads to these and other costs for both societies and individuals, as the number of chronic diseases and disabilities inevitably increases with advancing age. One out of three adults aged 65 and older falls each year (Hausdorff, Rios, & Edelber, 2001), and in 2010, the direct medical costs of falls (adjusted for inflations), was 30 billion USD in USA alone (Stevens, 2006). Thus, it is imperative for society as a whole to recognize the importance of helping seniors maintain their health and their engagement in daily life.

Physical activity and physical performance has unanimously been recognized as an essential element of a healthy and productive life among the ageing population (Taylor & Johnson, 2008). The greater the level of performance in specific physical fitness attributes, the greater the reserve capacity for the physical performance of activities of daily living and the potential for the continuation of the independent life of older adults. In addition, it is well recognized that regular physical activity and an appropriate level of physical fitness attributes produce major and extensive health benefits in this specific cohort. Regular exercise has been shown to provide a myriad of benefits in older adults and play an important role in enhancing quality of life and maintaining long-term independence (DiPietro, 2001; Shephard, 1993). Also, physical activity and structured exercises are connected to increased longevity among the elderly. Some studies found that modest increases in life expectancy were possible even among those who begin regular exercise after the age of 75 (Paffenbarger, 1995). It has been shown that compared to less active individuals, men and women who are more active have lower rates of all-cause mortality, coronary heart disease, high blood pressure, stroke, type 2 diabetes, colon cancer, breast cancer, higher level of cardiorespiratory and muscular fitness, healthier body mass and composition, and a more favorable biomarker profile (PAGAC, 2008; Bauman, Lewicka & Schoppe, 2005; Paterson, Jones & Rice, 2007; Paterson & Warburton, 2009). Thus, the assessment of fitness profiles among the elderly is very important. According to the Centers for Disease Control and Prevention (CDC), the definition of physical fitness emphasizes the difference between health-related physical fitness and athletic ability physical fitness. In this regard, the 5 health-related fitness components are more important than those related to athletic ability (or skill-related components). The Health Related Physical Fitness (HRPF) components are: Cardiorespiratory Fitness; Body Composition; Flexibility; Muscular Strength and Muscular Endurance.

Aging produces substantial changes in health-related physical fitness (HRPF), including body composition, skeletal muscle strength, sarcopenia, cardiovascular fitness (VO_{2max}) and flexibility (Taylor et al., 2008). It has been shown that disabilities are highly correlated with health related physical fitness scores (Porter, Vandervoort, & Lexell, 1995). Also, the impaired balance has a significant negative impact on mobility, functional independence, and fall risk in older adults, so it seems prudent to evaluate balance in this specific cohort.

The limitations of the data on the fitness profiles for this population in Serbia are a consequence of the lack of knowledge about tests available to assess the functional fitness of older adults, particularly tests which accompany performance standards, and a lack of understanding about its importance. Consequently, it could be of importance to establish the effect of aging on the level of the HRPF among the elderly, and get an insight into the relation between the HRPF and Health risk factors. Recognition and understanding of these relations may indicate that the low level of some components of the HRPF carry greater health risks, and it could leave the possibility that older adults improve their health level with programed physical activity.

This is a simple descriptive study about the profiles of selected health-related physical fitness variables among the elderly. Thus, there are two aims of this study: first, to evaluate the level of the HRPF, and second, to explore the relationship between the health risk stratification groups and the HRPF.

METHODS

The sample of participants

Forty-nine participants (20 females and 29 males), age 73.22±5.04, body height 168.78±9.17 cm, and body weight 76.73±12.19 kg were recruited for the study. All of the participants were physically independent. The tests and medical exams were conducted in two days; the first day was set aside for medical examination and the second for the HRPF tests. Before the tests procedure, the participants followed the following recommendations: avoiding food intake 4 hours before the test, alcohol and caffeine abstinence 12-24 hours before the test, no physical activity 24 hours before the test, no smoking 3 hours before the test, empty bladder 30 minutes before the testing commencement, and the control of drug intake. A team of 3 trained fitness professionals tested the participants individually. All of the tests were conducted in the morning (from 9-11am), at the Novi Sad City beach “Strand”. The temperature was 20 -22C, and humidity less than 60%. Prior to the test, the participants were instructed to perform the tasks as well as possible. The time needed for one person to complete the whole test battery, including pretesting health screening, was about 60 minutes. Appropriate safety was secured during the testing procedure. Before the tests, a five to ten minute warm-up was conducted as well as general stretching exercises. Prior to the commencement and after the termination of the trials, blood pressure and heart rate were measured. The performance of particular parts of the test was preceded by a demonstration and the participants first checked their ability to perform particular tests in order to get familiar with their proper course. Contraindications for the performance of the test included: participant's overall poor health, chest pain (discomfort), unstable angina pectoris, uncontrolled blood pressure exceeding 160/100 mmHg.

Instruments and procedures

For the purpose of health status estimation, questionnaires and medical exams were used. All of the participants were informed in detail about how to fill in the questionnaire.

The assessment of health status was obtained by:

- *Medical Anamnesis (examination)*

Resting Heart rate (RHR) and Resting Blood pressure (systolic (SBP) and diastolic (DBP)) - (Resting Heart rate and blood pressure were measured as health indicators)

- *Risk Factor Stratification (RFS)* (ACSM, 2010a) (3 groups) was used: low risk (asymptomatic, ≤ 1 total risk factor); moderate risk (asymptomatic, ≤ 2 total risk factor); high risk (symptomatic, or known cardiac, pulmonary, or metabolic disease).

A spectrum of complementary examinations was made to evaluate morphological status – body composition (Body mass index, Body fat percentage, and Waist to hip ratio), and health-related physical fitness levels:

Body Composition (BMI): The body height and weight of the selected participants were measured under the protocol in accordance with the International Biological Program. These measurements were then used to calculate the BMI.

Bioelectrical impedance analysis measurements were used for body composition analysis (impedance meter; MALTRON® BF-906, Rayleigh, UK), obtaining an estimate of body fat percentage.

Waist to hip ratio (WHR) was measured according the WHO data gathering protocol, (WHO, 2012).

Balance: the Standing Stork stand test was used (Johnson & Nelson, 1979).

Flexibility: the Sit-and-reach test was used (Osness et al., 1990).

Muscle Strength: Hand grip strength was determined using a Jamar® hydraulic hand dynamometer (Sammons Preston, Bolingbrook, IL), under the ACSM protocol (ACSM, 2010b).

Cardiovascular fitness: The Rockport fitness test was carried out to assess aerobic capacity and cardiovascular response. The value of VO_2 max was calculated with the equation (Kline et al., 1987; McSwegin, Plowman, Wolf, & Guttenberg, 1998).

Statistical analyses

Basic descriptive statistics were calculated. The testing of the significant differences between the HRPF and health risk factor groups was determined using the one-way univariate analysis of variance (ANOVA), with a 95% confidence level ($p < .05$). The relationship between the health risk stratification factor and the HRPF was assessed by Pearson's correlation coefficients ($p < .05$). All of the analyses were carried out using SPSS software, version 17.0 (SPSS Inc, Chicago, IL).

RESULTS

Most of the participants were in the age range of 70-74 (34.7%). Average body height of the males was 174.98±5.60 cm, and of the females 159.80±4.77 cm, and body weight for the males 82.66±10.50 kg and the females 68.13±9.03 kg. Data for the full sample are shown in detail in Table 1.

The Risk Factor Stratification divided the participants into three health risk groups:

- Low risk (asymptomatic, ≤ 1 total risk factor) – 36.7% of the participants (26.5% males; 10.2% females).
- Moderate risk (asymptomatic, ≤ 2 total risk factor) – 16.3% of the participants (10.2% males; 6.1% females).
- High risk (symptomatic, or known cardiac, pulmonary, or metabolic disease) – 46.9% of the participants (22.4% males; 24.5% females).

Table 1 Descriptive statistics

	N	M±SD	R
BFAT(%)	49	31.23 ± 7.45	21.1 – 46.5
BMI(kg/m^2)	49	26.94 ± 3.43	18.7 – 35.5
WHR(cm)	49	89.0 ± .08	70.0 –107.0
BALANCE(s)	49	40.34 ±62.43	2.0 –332.0
FLEXIBILITY(cm)	49	21.90 ±12.72	10.0 – 46.0
STRENGTH(kg)	49	56.19 ±16.05	22.0 – 90.2
VO_{2max}(ml.kg^{-1}.ml^{-1})	49	28.48 ± 8.67	11.0 – 44.0
RHR (bpm)	49	68.43 ± 9.52	49.0 – 95.0
SBP (mmHg)	49	137.24 ±15.25	103.0 –166.0
DBP (mmHg)	49	80.04 ± 9.05	60.0 –100.0

The results of one-way univariate analysis of variance (ANOVA) between the low, moderate and high health risk level participants showed a statistically significant difference in hand grip strength between the low risk and high risk participants ($p = 0.04$).

The results of Pearson's correlation between the Risk Factor stratification and HRPF are shown in Table 2.

Table 2 Correlation between Risk Factor Stratification and HRPF

RFS	**r**
BFAT	–.071
BMI	.089
WHR	.208
BALANCE	**–.417***
FLEXIBILITY	–.286
STRENGTH	.027
VO_{2max}	**–.426***
RHR	.093
SBP	–.054
DBP	–.178

*Correlation significant at the 0.05 level (2-tailed)

There is a moderate negative relationship between the health risk factor and HRPF in balance and cardiovascular fitness.

DISCUSSION

The general goal was to assess the fitness profiles of one group of the elderly in Serbia, since limited data are available. The results of body composition show obesity, and the HRPF level indicates high cardiovascular disease risk, muscle strength at risk level, and flexibility and balance at a satisfactory level for this age. The data can be compared with the fitness profiles identified in other studies, in order to design a physical activity program to improve the level of HRPF. The relationship between health risk factors and HRPF level leaves open the possibility that increasing the level of some elements of the HRPF reduces health risk among the elderly.

As health indicators, the measured blood pressure at rest (systolic) indicates a prehypertension state while the diastolic was in the normal range (NIH, 1997), and resting heart rate was in the average range (YMCA, 1989). High blood pressure presents a risk for heart disease and stroke, which is one of the leading causes of death (Kochanek, Xu, Murphy, Miniño, & Kung, 2011). In 2009, 13% of all deaths globally are attributed to high blood pressure, making it an area of prime importance for public health (WHO, 2009). The resting heart rate is a significant predictor of all-cause mortality, and many of them have found similar predictive value when it comes to cardiovascular disease risk. Elderly with higher RHR (>79 beats per minute) had an 85% increased risk of cardiovascular and non-cardiovascular mortality compared to those with lower RHR (<62 beats per minute); the odds ratio of all-cause mortality rose 22% with each increase of 10.6 beats per minute in RHR; (Legeai et al., 2011).

The results of Risk Factor Stratification showed that 64.3% of the participants have moderate and high health risks (the females twice more than the males). Interestingly, nearly half of the participants have a symptomatic cardiac, pulmonary, or metabolic disease.

Data for health-related fitness profiles among the elderly from similar studies are shown in Table 3.

Table 3 Health-related fitness profiles of the elderly

Authors	Age	N	BMI	BFAT	BAL.	FLEX.	STRENGTH	VO_{2max}
Lemmink et al., (2001)	66.6±7.4	154 (m,f)*			74.6±10.3	20.7±9.3	44.6±7.4	
Ciardullo et al., (2003)	60.9±6.5	336 (m,f)	26.8±3.4	29.9±6.8				24.4±17.8 (2km walk test)**
De Jong et al., (2006)	59.6±2.4	79 (m,f)	26.9±3.2	32.3±8.4		29.3±9.5	49.7±13.0	
Wanderley et al., (2011b)	68.9±5.4	105 (m,f)		35.9±6.9				20.1±6.3 (6MWT – 6 minute walking test)
Bouchard et al., (2011)	68.5±5.0	61 (m)	30.1±3.1	41.6±9.7				24.5±5.1 (Mod.Balke& Ware treadmill test)
Wanderley et al., (2011a)	68.0±5.5	85 (m,f)	28.3±4.5				28.2±8.8	20.4±6.6 (6MWT)
Kimura et al., (2012)	73.2±5.6	44 (m,f)			51.5±42.1	35.5±7.4	28.1±4.9	
Seco et al., (2013)	70.5±4.9	247 (m,f)	29.9±4.1	29.2±6.3		14.94±6.5	53.0±15.0	21.9±6.9 (Rockport test)
Teixeira et al., (2012)	66.0±6.0	30 (m,f)	28.0±4.0		18.0±11.0	19.0±9.0	30.0±7.0	17.0±7.0 (6MWT)

* gender (m – male, f – female), ** test protocol

According to the WHO, the incidence of overweight and obesity is increasing worldwide and is ranked as the fifth cause of death behind high blood pressure, tobacco use, high glucose and physical inactivity (Flegal, Carroll, Kit, & Ogden, 2012; Stamatakis, Zaninotto, Falaschetti, Mindell, & Head, 2010).

The body mass index and body fat percentage indicate overweight/overfat at a high risk level (Expert Panel on the Identification Evaluation and Treatment of Overweight in Adults, 1998; ACSM, 2010b; Gallagher et al., 2000), which could lead to various chronic diseases (Pai, 2011; Perissinotto, Pisent, Sergi, & Grigoletto, 2002). The results are the same as those in a recent study done in this region (Milanovic, Pantelic, & Jorgic, 2012). More than half of the individuals showed high waist circumference measures, which represents a high metabolic risk factor. The waist-to-hip ratio and BMI are similarly strong predictors of type 2 diabetes (Vazquez, Duval, Jacobs, & Silventoinen, 2007; Qiao & Nyamdorj, 2010). Body fat mass and waist circumference were considered better indicators for cardiovascular disease risk than BMI (Lee, Huxley, Wildman, & Woodward, 2008). In a study on the health status level in Novi Sad (2011), the prevalence of sarcopenic obesity in an elderly population of females was 92.96% and males 79.31% (Matijevic & Stokic, 2012) and the death rate of cardiovascular disease in 2009 was 48.4% (Institute for Public Health of Vojvodina, 2010).

Balance is above average (Schell & Leelarthapin, 1994) and flexibility is in the range of average (ACSM, 2010b). The results obtained in this study are better compared to those obtained in the study carried out by Milanovic et al. (2012), but lower in comparison to studies conducted in Japan and the Netherlands (Lemmink et al., 2001; Kimura et al., 2012). It could be a consequence of better organized physical activity of the elderly in the Netherlands, and especially in Japan, where traditionally, Tai Chi has proven to be effective at improving musculoskeletal fitness by increasing low back flexibility, balance and overall physical health.

Grip strength results are at risk level (CSEP, 2003), as is and cardiovascular fitness (ACSM, 2010). In comparison to the studies shown in Table 3, the obtained results are better. One of the reasons could be the selection of participants; while in other studies they were selected to identify the specific cohort, in this study they participated voluntarily, and they belong to an independent and active group of the elderly.

Hand grip strength was identifying as a health risk factor which may lead to a difference between a low and high health risk level participant. Low handgrip strength has been linked to premature causes mortality, disability and other health complications in older people (Sasaki, Kasagi, Yamada, & Fujita, 2007). A significant negative relationship between the health risk factor and balance and cardiovascular fitness indicates that lower levels of these components of HRPF increase health risks in the elderly. Up to 30%-60% of community-dwelling older adults fall each year, and 5%-10% of these falls result in serious injury (Granacher, Muehlbauer, & Gruber, 2012). A major contributor to falls among the elderly is the diminished functioning of a number of physiological systems, in particular the sensory motor system, which contributes to balance and stability (Woolacott & Shumway-Cook, 1990). Cardiovascular fitness can be a powerful predictor of mortality among men than other established risk factors for cardiovascular disease; each 1-MET increase in exercise capacity (MET = Relative VO_2/3.5 ml/kg/min) conferred a 12 percent improvement in survival (Myers et al., 2002).

Recommendation

This study is one of the rare studies on the HRPF of the elderly in Serbia. Physical fitness profiles provide information about less developed physical-fitness components and can be used to give a personal physical activity recommendation. A policy should be proposed to enhance the health effects and outcomes of physical activity and exercise of the elderly. Programs of physical activity should be aimed at increasing their level of strength, cardiovascular fitness and balance, because the aging process decreases muscle strength and has an impact on endurance in elderly people, so these parameters lead to greater health risks. Physiology and kinesiology recommend for the elderly in particular, cyclic endurance sports (swimming, cycling, running, cross-country skiing, walking quickly), given that the possibility of injury is very low. Older people need to enjoy the sport and the game, the game itself must be at such a level so as to exclude the possibility of injuries and overload. Physical activity interventions are a cost-effective approach, and the potential economic benefits from increased physical activity should be considered (Munro, Nicholl, Brazier, Davey, & Cochrane, 2004).

Limitations of the Study

The lack of a reasonably large number of participants is the limitation of this study; it was too small group to make assumptions of the fitness level of all the elderly in Novi Sad. The reason for such a shortage of participants was that the participants volunteered to take part in the research during their visit to the city beach. In future studies, weigh-population analysis should been taken into consideration in order to properly represent the whole population. The test of muscle endurance is missing and should complete the test battery for the evaluation of the HRPF. These test protocols were selected because they were already used on the elderly and were easy to administer, and for financial reasons (budgeting, staff and training needs). More valid tests are suggested for the assessment of the elderly (e.g. Groningen battery, Senior fitness test), but he Rockport Fitness walk Test was selected because we already had a marked one mile track, instead of organizing equipment for the Groningen walking test. In addition, for the balance test, the one leg stork test was selected as easier than the Balance Board Test. The applied test procedures for the estimation of the HRPF are mostly assessed through indirect measurement, so the validity and reliability of these results can be questioned.

CONCLUSION

More than half of the participants belong to the moderate and high health risk group. The analyses of morphological status indicate overweight and overfat and a high risk of cardiovascular disease, including the prehypertension state. Analyses of functional status indicate, in general, aerobic capacity at risk level, muscle strength at risk level, and flexibility and balance at satisfactory level for this age group. There is a moderate negative relationship between the health risk factor and some components of the HRPF (balance and cardiovascular fitness).

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NIVO FIZIČKE FORME POVEZANE SA ZDRAVLJEM KOD STARIJIH OSOBA

Studija je dizajnirana u cilju utvrđivanja nivoa zdravstvene fizičke forme osoba starije dobi. Četrdeset devet starijih osoba prosečne starosti 73,22 ± 5,04 godina (20 žena i 29 muškaraca) činilo je uzorak ispitanika. Procenjivano je zdravstveno stanje, telesna kompozicija i zdravstvena fizička forma. Razlike između analiziranih varijabli i zdravstveno rizičnih grupa ispitanika utvrđene su primenom Univarijatne analize varijanse (ANOVA) na nivou značajnosti od 95% (p<,05). Povezanost između zdravstvenog faktora rizika i zdravstvene fizičke forme utvrđena je pirsonovom korelacionom analizom (p<,05). Stratifikacijom zdravstvenog faktora rizika ispitanici su grupisani u grupe: niskog rizika – 36,7%; umerenog rizika – 16,3% i visokog rizika – 46,9% ispitanika. Statistički začajna razlika utvrđena je u testu - stisak šake (p = 0,04) između ispitanika sa niskim i visokim nivoom zdravstvenog rizika. Utvrđena je i umerena negativna korelacija između zdravstvenog faktora rizika i ravnoteže (r = –,417) i kardiovaskularne forme (r = –,426). Analiza zdravstvenog statusa ukazuje na prehipertenziju ispitanika. Rezultati analize telesne kompozicije ukazuju na prekomernu težinu, nivo zdravstvene fizičke forme ukazuje na visok rizik od bolesti kardiovaskularnog sistema, snaga je na nivou rizika, dok su fleksibilnost i ravnoteža na zadovoljavajućem nivou za ovu uzrasnu populaciju.

Ključne reči: *kardiovaskularna forma, snaga, gipkost, ravnoteža.*