# EFFECTS OF 24-WEEK AEROBIC TRAINING PROTOCOL ON PHYSIOLOGICAL ABILITIES AND QUALITY OF LIFE OF FREE-LIVING ELDERLY FEMALES

**Tomislav Krističević, Miro Hrženjak and Goran Sporiš**

*Faculty of Kinesiology, University of Zagreb, Zagreb, Croatia*

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**Abstract**

*The purpose of the study was to determine possible effects of 24-week aerobic training protocol on physiological abilities and quality of life of free-living elderly females. Fifteen (n=15) elderly females were divided into experimental (active elderly woman; n=7, age 64.11±3.06 years, height 157.21±6.12 cm, weight 76.78±15.56 kg, body mass index 29.73±4.44 kg/m$^2$) and control (non-active elderly woman; n=8, age 67.78±5.29 years, height 160.02±2.75 cm, weight 70.69±6.90 kg, body mass index 27.43±3.94 kg/m$^2$) group. Senior Fitness Test (SFT) and World Health Organization Quality of Life Questionnaire (WHOQOL-BREF) were used as measures for physiological abilities and quality of life, respectively. After 6 months, active elderly woman had significant improvements in aerobic endurance capacity measured with 2-Minute Step Test (ES=1.63; p=0.026) and agility with dynamic balance measured with 8-Foot Up-and-Go Test (ES=1.37; p=0.023), while body weight was significantly decreased (ES=0.17; p=0.013). Also, higher values were observed in physical (ES=0.72; p=0.024) and psychological health quality of life domains (ES=0.71; p=0.007). Non-active group showed no statistical changes in a 6 month period. In conclusion, long-term aerobic physical activity has positive effects on improving or maintaining physical fitness and quality of life among female elderly adults, prolonging a healthy way of living.*

***Key words:*** *senior fitness tests, quality of life, geriatrics, physical activity*

## Introduction

As it is known, physical activity potentially has many health benefits (Centers for Disease Control and Prevention, 2011), including prevention from cardiovascular diseases (Molmen et al., 2012; Williams & Stewart, 2009), metabolic diseases (Hahn et al., 2009; Smutok et al., 1993), falls (Sherrington and Tiedemann, 2015), loss of cognitive functions (Smith et al., 2010), sarcopenia (Montero-Fernandez & Serra-Rexach, 2013), obesity (Hu et al., 2004), osteoporosis, some forms of cancer (colon, breast, prostate and lung), hypertension, stroke and diabetes (Berger et al. 2007; Wiest and Lyle, 1997). Also, there are growing number of evidence suggesting that involvement in regular PA can help minimize biological changes associated with aging, reverse disuse syndromes, improve chronic diseases, increase mobility and function, maximize psychological health and help with rehabilitation from numerous diseases (Koltyn, 2001; American College of Sports Medicine, 2009).

The prevalence of all mentioned diseases increases with age, causing imbalance and disability, especially among elderly population (Seeman et al., 2010; Palacios-Cena et al., 2012). It has been said, that by 2050, the number of elderly people will increase for around 20% (United Nations, 2005). Because of that, it is very important to help elderly people to improve and maintain their functional fitness in everyday activities (Rimmer, 1994). One of the most researched topics among elderly population has been physical activity (PA) (DiPietro et al., 1993; Westerterp, 2000). It has been estimated that only 0.6% Croatian people older than 65 engage in some form of regular, organized PA (Lepan and Leutar, 2012). In general, those people who were active showed participation in only low-intensity physical activities (walking, low aerobic activities) (Rafferty et al., 2002; Shoenborn, 2004). However, physical fitness, which represents capability of doing everyday activities without getting tired (Mišigoj-Duraković, 1999), is declining according to age, decreasing individual strength, flexibility, aerobic parameters and agility (Rikli and Jones, 2013). Many older adults, because of their sedentary lifestyles, are not able to perform normal daily activities (Rikli and Jones, 2013). Studies suggest that physical functioning is preserved at a much higher level among physically active older adults (ACSM, 2009; Physical Activity Guidelines Advisory Committee, 2008). Sadly, only 5% of those active people fit in a high-fit group or elite level, while around 65% fit under the independent, but low-active category (Spirduso et al., 2005). Evidence showed that PA is highly associated with functional status and maintaining functional fitness of older women (Brach et al., 2003; Milanović et al., 2013).

Positive effects of PA on functional fitness can also be transferred to quality of life domains (QOL) (Miller et al., 2000). There are accumulating amount of evidence suggesting that planned and structured PA is associated with enhanced mood, stress reduction, more positive self-concept and higher quality of life (Berger, 1996). In literature, quality of life is defined as individuals' perceptions of their position in life in the context of the culture and value systems in which they live and in relation

to their goals, expectations, standards and concerns (The World Health Organization Quality of Life Group, 1996). There has been lacking of studies combining effects of PA on functional fitness test and QOL domain results. Thus, the aim of present study was to determine the effects of 24-week aerobic training protocol on physiological abilities and quality of life among elderly female adults.

## Materials and methods

*Participants*
Fifteen elderly female adults were divided in the free-living experimental "active" (EG) and the control "non-active" (CG) group. EG was consisted of 7 females (age 64.11±3.06 years, height 157.21±6.12 cm, weight 76.78±15.56 kg, body mass index 29.73±4.44 kg/m$^2$), also like the CG (age 67.78±5.29 years, height 160.02±2.75 cm, weight 70.69±6.90 kg, body mass index 27.43±3.94 kg/m$^2$). All participants were healthy without any health problems or conditions. The study was approved by the Ethics Committee of Faculty of Kinesiology and testing protocol was conducted according to Declaration of Helsinki.

*Measures*
Senior Fitness Test: Functional fitness was assessed using Senior Fitness Test, which was comprised from eight individual tests: (1) "30-Second Chair Stand Test" for assessing lower body strength, (2) "30-Second Arm Curl Test for assessing upper-body strength, (3) "2-Minute Step Test" to assess aerobic endurance capacity, (4) "Chair Sit-and-Reach Test" to assess lower-body flexibility, (5) "Back Scratch Test" to assess upper-body (shoulder) flexibility, (6) "8-Foot Up-and-Go Test" for assessing the agility and dynamic balance, (7, 8) "Height" and "Weight" to assess ratio between weight and height to determine Body Mass Index (BMI) (kg/m$^2$) (for more information, see Rikli and Jones, 2013).

Quality of Life Questionnaire (WHOQOL-BREF): The questionnaire was comprised of twenty-four items with two additional question about self-rated general quality of life and satisfaction with health. In addition, four domains were extracted from the questionnaire: physical health domain, psychological health domain, social relationships domain and environment domain. Answers in each question were given through the Likert scale from 1 to 5, where 1 represented the lowest agreement with particular item, while 5 indicated the highest agreement (Martinis, 2005). Finally, the answers were transformed on a scale from 0-20 points. Previously, all domains showed great discriminative ability, especially in physical health and psychological domains (Skevington et al., 2004).

*Testing protocol*
All procedure was conducted from the 15$^{th}$ of September, 2015 to the 15$^{th}$ of March, 2016. At the beginning, eighteen participants filled the WHOQOL-BREF questionnaire and SFT protocol. Testing procedure was undertaken between 19:00-20:00 pm and the average indoor temperature was between 24-26 Cº. Training protocol for EG in 6-month period was consisted of 10-minute stretching at the beginning of practice, followed by static and dynamic exercises in standing position for 10 minutes. After that, participants practiced exercises with lots of repetitions (for example, lateral hand and leg lifting, adapted exercises for abdominal muscles in static and dynamic positions, along with exercises for back muscles). Stretching exercises were performed within last 10 minutes of practice. EG were involved in this form of PA twice a week (Wednesday and Friday).

*Statistical analysis*
Descriptive statistics (mean±standard deviation) were calculated for all measured variables. Shapiro-Wilks test was used to determine distribution normality. Differences between initial and final testing were determined using Student paired t-test. Also, effect size (ES) was calculated and interpreted by Cohen's instructions (Cohen, 1988). STATISTICA Statsoft, Inc., Tulsa, OK. Version 11) was used for the statistical analysis. The significance was set up at $\alpha \leq 0.05$.

## Results

The Shapiro-Wilks test showed that data were normally distributed. Descriptive statistics (arithmetic mean±standard deviation with 95% CI) were presented in table 1. Aerobic PA (active women group) had statistically significant effect on aerobic endurance capacity measured with2-Minute Step Test (+36.66%), agility and dynamic balance measured with8-Foot-Up-and-Go Test (-12.67%) and body weight (-3.11%) ($p \leq 0.05$).

Results in other variables did not show statistical significant differences between the initial and final testing, but there was increasing tendency of values occurred in lower body strength (30-Second Chair Stand), upper-body strength (30-Second Arm Curl Test) and lower body flexibility (Chair Sit-and-Reach Test), while results decreased in upper-body flexibility (Back Scratch Test) ($p>0.05$). Although no statistical differences between two measurements occurred in the CG (non-active group), there has been decreasing tendency of values in each variable, except in agility and dynamic balance (8-Foot Up-and-Go Test- lower value means better result) and body weight.

Differences between QOL domains in each group were presented in table 2.

Aerobic PA (active woman group) had significant positive impact on physical health (+7.77%) and psychological health (+7.33%) domains among EG between two trials ($p \leq 0.05$). Nevertheless, results in two other domains showed non-significant positive effects on social relationships (+4.56%) and environment (+3.93%) domains. Results among CG (non-active woman) did not significantly differ between the initial and final testing ($p>0.05$).

**Discussion and conclusion**

The aim of present study was to determine effects of aerobic PA on physiological abilities and quality of life among free-living elderly females. Results on SFT and WHOQOL-BREF after 6 months showed significant differences only in physically active elderly women while results for non-active elderly women stayed the same. Greatest differences on physiological measures were on 2-Minute Step Test (ES= 1.63, p=0.026), 8-Foot Up-and-Go Test (ES=1.37, p=0.023) and Body Weight (ES=0.17, p=0.013), while the greatest differences on quality of life domains occurred in physical (ES=0.72, p=0.024) and psychological (ES=0.71, p=0.007) health. This means that older women involved in regular PA improved their aerobic endurance capacity, agility and dynamic balance but also reported significantly less physical pain and discomfort, more energy, better mobility, more sleep, less need for daily medical treatments and better work capacity after 6 months of training. Furthermore, they experienced more positive and less negative feelings, higher satisfaction with bodily image and appearance, improvements on self-esteem, personal beliefs, thinking, learning and concentration. Non-active older women didn't experience any of these improvements in a 6 months period.

Table 1. Differences between initial and final testing in senior fitness tests among active and non-active elderly women

| Senior Fitness Tests | Baseline AM±SD (95% CI) | After 24 weeks AM±SD (95% CI) | Effect size (d) | p-value |
|---|---|---|---|---|
| **30-Second Chair Stand Test** | | | | |
| Active | 16.86±3.98 (13.18 to 20.53) | 19.14±2.27 (17.04 to 21.24) | 0.70 | 0.199 |
| Non-active | 16.62±3.33 (13.84 to 19.41) | 16.25±2.60 (14.07 to 18.43) | -0.12 | 0.442 |
| **30-Second Arm Curl Test** | | | | |
| Active | 19.86±5.64 (14.64 to 25.07) | 22.71±3.82 (19.18 to 26.24) | 0.59 | 0.402 |
| Non-active | 17.25±2.66 (15.03 to 19.47) | 16.87±2.42 (14.85 to 18.89) | -0.15 | 0.197 |
| **2-Minute Step Test** | | | | |
| Active | 80.28±15.62 (70.84 to 99.73) | 109.71±20.24 (101.28 to 116.72) | 1.63 | **0.026** |
| Non-active | 56.43±11.00 (45.90 to 65.36) | 55.62±10.80 (46.60 to 64.65) | -0.07 | 0.095 |
| **Chair Sit-and-Reach Test** | | | | |
| Active | 1.28±1.38 (0.00 to 2.56) | -2.85±5.73 (-8.15 to 2.44) | 0.99 | 0.128 |
| Non-active | -1.97±5.60 (-6.65 to 2.71) | -1.59±5.55 (-6.23 to 3.05) | -0.07 | 0.177 |
| **Back Scratch Test** | | | | |
| Active | -10.21±9.87 (-19.34 to -1.08) | -0.93±13.32 (-13.25 to 11.39) | 0.79 | 0.240 |
| Non-active | -1.28±11.79 (-11.14 to 8.58) | -1.19±11.86 (11.10 to 8.73) | -0.01 | 0.200 |
| **8-Foot Up-and-Go Test** | | | | |
| Active | 5.68±0.59 (5.13 to 6.23) | 4.96±0.45 (4.36 to 5.56) | 1.37 | **0.023** |
| Non-active | 7.11±1.52 (5.85 to 8.39) | 7.17±1.46 (5.98 to 8.40) | 0.04 | 0.511 |
| **Body Weight** | | | | |
| Active | 81.08±15.65 (66.61 to 95.55) | 78.56±14.66 (65.00 to 92.12) | 0.17 | **0.013** |
| Non-active | 75.78±12.93 (64.96 to 86.58) | 76.09±12.31 (65.79 to 86.38) | 0.02 | 0.340 |

p≤0.05

Similar results on physiological abilities were obtained in the study conducted by Martins et al. (2011). After 16 -week training program, aerobic group increased their results in all variables, except in Back Scratch Test, where there were no significant differences between the baseline and after 16-week training period. In this research 2-Minute Step Test was used to assess aerobic endurance (Rikli& Jones, 2013) among active and non-active elderly woman. Because of training protocol, which included lots of rhythm exercises, including steps, lifting knees, along with frontal and lateral movements, very large effects occurred in mentioned variable. It stated, that around 20% of peak oxygen uptake declines per decade (Fleg et al., 2005), while some other authors suggests declining for 10% per decade (Hawkins &Wiswell, 2003). 8-Foot Up-and-Go Test was used to assess speed, frontal agility, reaction time and dynamic balance (Rikli& Jones, 2013). Studies investigating balance reported, that aging process has been related to balance instability (Norton et al., 1997; Bohannon, 1997). In the present study, active woman improved their results for almost 13%, which meant that they had positive neuromuscular adaptations on the training program. Improvements were translated into specific functional everyday activities, such as getting up

from chair, going to the bathroom or cook (Martins et al., 2011). Statistical significant reduction was also observed in Body Weight (for almost 3 kg), while the non-active woman had tendency of increasing body mass. Although, body composition was not measured during the study, we assume that the active woman had different distribution between percentage of muscle mass, subcutaneous fatty tissue and water. No statistical differences were found in 30-Second Chair Stand Test and 30-Second Arm Curl Test. This could be explained by the fact, that active woman did not have enough external stimuli (for example, resistance training), or the resistance exercises were low-intensity based, which statistically did not have any increments in upper or lower body strength ($p>0.05$). The EG improved their lower body flexibility for around 4 cm, but reduced values in Back Scratch Test (for 9.28 cm), because lacking of exercises for improving upper body flexibility. Another possible reason why significant changes did not occur may be because of higher performance on these tests at the beginning of testing (Martins et al., 2011).

Table 2. Differences between initial and final testing in quality of life domains among experimental and control group

| Quality of Life domains | Baseline AM±SD (95% CI) | After 24-weeks AM±SD (95% CI) | Effect size (d) | p-value |
|---|---|---|---|---|
| **Physical health domain** | | | | |
| Active | 17.63±2.26 (16.26 to 19.00) | 19.00±1.12 (18.14 to 19.86) | 0.72 | **0.024** |
| Non-active | 15.77±2.43 (14.23 to 17.32) | 15.50±2.34 (14.00 to 17.00) | 0.11 | 0.064 |
| **Psychological health domain** | | | | |
| Active | 17.18±1.79 (16.10 to 18.26) | 18.44±1.74 (17.11 to 19.78) | 0.71 | **0.007** |
| Non-active | 14.44±2.50 (12.85 to 16.03) | 14.33±2.42 (12.79 to 15.87) | 0.04 | 0.263 |
| **Social relationships domain** | | | | |
| Active | 17.74±2.80 (16.05 to 19.43) | 18.55±1.74 (17.22 to 19.89) | 0.33 | 0.152 |
| Non-active | 14.19±1.92 (12.97 to 15.42) | 14.08±2.23 (12.66 to 15.50) | 0.05 | 0.541 |
| **Environment domain** | | | | |
| Active | 18.81±1.31 (18.01 to 19.60) | 19.55±0.73 (19.00 to 20.11) | 0.65 | 0.069 |
| Non-active | 15.71±2.26 (14.27 to 17.14) | 15.50±2.24 (14.08 to 16.92) | 0.09 | 0.175 |

$p \leq 0.05$

In this research, results confirmed that involvement in regular physical activity for 6 mounts significantly increased physical and psychological health domains of quality of life for older women. This result is in line with some previous research findings on older adults. Mcauley et al. (2006) found that PA influenced self-efficacy and QOL through physical and mental health status, which in turn influenced global QOL. Using the same QOL questionnaire as we did, Koltlyn (2001) found some significant positive associations between PA and QOL domains in older women: overall QOL was associated with greater energy expenditure (kcals/week) and vigorous activities, while physical health was associated with more total time being spent physically active (hours/week), greater energy expenditure and vigorous activity.

Overall, there have been consistent positive associations between PA level and health-related QOL (Bize et. al. 2007). Elavsky et al. (2005) in their 4 year study found that PA was related to self-efficacy, physical self-esteem and positive affect at 1 year measuring point, and in turn greater levels of self-efficacy and positive affect were associated with higher levels of QOL. After 4 years, changes in PA were related to increase in physical self-esteem and positive effect, but only positive affect directly influenced improvements in QOL. This evidence suggests that involvement in regular PA possibly can have long-term benefits on participant's QOL. Awick et al. (2015) assigned 179 low active, community-dwelling older adults to either 12-month aerobic walking group or strengthening and flexibility group and then measured their health-related QOL and global QOL. Results showed that both exercise groups evidenced an increase in global QOL with aerobic group showing linear increase across the trial and increase in mental status of HRQOL while the values for the physical health status remained stable across the trial. With age, people become increasingly susceptible to chronic diseases and functional disability which can compromise physical and psychological health and reduce their quality of life. "Although no amount of physical activity can stop the biological aging process, there is evidence that regular exercise can minimize the physiological effects of an otherwise sedentary lifestyle and increase active life expectancy by limiting the development and progression of chronic disease and disabling conditions. There is also emerging evidence for significant psychological and cognitive benefits accruing from regular exercise participation by older adults." (American College of Sports Medicine, 2009; p.1510).

Numerous research have shown that exercise can have great impact on participant's mood alteration, especially short-term decreases in anxiety, depression, anger and fatigue as well as increases in well-being, alertness, vigor, vitality, clear thinking and energy (Berger et. al. 2007; Berger, 1996). Also, exercise is one of the few stress management technique that can serve to either lower or raise participant's stress levels (Berger et. al. 2007). Furthermore, there are evidences that exercise can enhance self-esteem, increase confidence and help members of physical population lower their levels of anxiety and depression (Berger et. al. 2007; Wiest, 1997). Already healthy individuals can involve in exercise

to develop even higher levels of physical and psychological health, but exercise can also be used to prevent and treat wide variety of diseases. Of course, to gain all this benefits and enhance their QOL throughout all stages of life, people must be involved in regular PA preferably for a longer period of time. Results in this study clearly show how involvement in regular PA can have positive influences on older women's physical abilities and quality of life in comparison to non-active older woman who didn't show any improvement. In order to enhance physical and psychological benefits of exercise, especially for older people, some requirements should be met. Physical activity programs for older adults should include aerobic, muscle strengthening and flexibility exercises (American College of Sports Medicine, 2009), present an enjoyable activity, have a relative absence of competition, predictable moving patterns, repetitive and/or rhythmical movements, be performed on mostly moderate intensity and in duration of minimum 20-30 minutes at least 3 times a week (Berger et. al. 2007; Berger, 1996) but preferably every day (American College of Sports Medicine, 2009).Overall, the programs that may particularly appeal to older adults are more moderate in intensity, simple and convenient to engage, inexpensive, noncompetitive and, especially for older women, contain some sort of social component (King, 2001). However, Rejeski and Mihalko (2001) suggested that meeting these specific criteria for frequency, intensity and duration are not enough for QOL outcomes. How programs are run and the input that participants have in their design are believed to be as critical and important as the guidelines stated above. So, if we want to improve participants QOL exercise prescriptions should target areas of function that are valued by participants themselves and relevant to their daily lives.

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## UČINCI 24-TJEDNOG PROTOKOLA AEROBNOG TRENINGA NA FIZIOLOŠKE SPOSOBNOSTI I KVALITETU ŽIVOTA SLOBODNIH STARIJIH ŽENA

**Sažetak**

*Svrha ovog istraživanja bila je utvrditi moguće učinke 24-tjednog protocola aerobnog treninga na fiziološke mogućnosti i kvalitetu života slobodnih staijih žena. Petnaest (n=15) starijih žena bilo je razdvojeno u eksperimentalnu (aktivne starije žene; n=7, uzrast 64.11±3.06 god., visina 157.21±6.12 cm, težina 76.78±15.56 kg, indeksa tjelesne mase 29.73±4.44 kg/m$^2$) i kontrolnu (neaktivne starije žene; n=8, uzrast 67.78±5.29 god., visina 160.02±2.75 cm, težina 70.69±6.90 kg, indeks tjelesne mase 27.43±3.94 kg/m$^2$) skupinu. Test fitnesa seniora (SFT) i Upitnik o kvaliteti života Svjetske zdravstvene organizacije (WHOQOL-BREF) korišteni su kao mjere za fiziološke sposobnosti i kvalitetu života, respektivno. Nakon 6 mjeseci, aktivne starije žene imale su značajne napretke u kapacitetu aerobne izdržljivosti, mjerenom 2-minutnim step testom (ES=1.63; p=0.026) te pokretljivosti s dinamičkom ravnotežom /8-Foot Up-and-Go test/ (ES=1.37; p=0.023), dok se tjelesna težina značajno smanjila (ES=0.17; p=0.013). Također, više vrijednosti opažane su u fizičkoj domeni (ES=0.72; p=0.024) te domeni psihološkog zdravlja i kvalitete života (ES=0.71; p=0.007). Neaktivne skupine nisu pokazale statističke promjene u vremenskom razdoblju od 6 mjeseci. Zaključno, dugoročna aerobna tjelesna aktivnosti ima pozitivne učinke na poboljšanje ili održavanje tjelesnog fitnesa i kvalitete života među odraslim starijim ženama, prolongirajući zdrav način života.*

***Ključne riječi:*** *fitnes test starijih ljudi, kvaliteta života, gerijatrija, tjelesna aktivnost*

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*Correspondence to:*
*Assist. Prof. Tomislav Krističević, PhD.*
*University of Zagreb*
*Faculty of Kinesiology*
*Zagreb, Croatia 10 000, Horvaćanski zavoj 15*
*Tel: +385 (1) 3658 666*
*e-mail: tomislav.kristicevic@kif.hr*