Coll. Antropol. **35** (2011) 3: 889–894
Original scientific paper

Effect of Nordic Walking on Functional Ability and Blood Pressure in Elderly Women

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A B S T R A C T

The aim of the study was to analyze the effects produced by the use of experimental program (Nordic polewalking) on functional abilities in elderly women. Three-month polewalking led to reduction in the pulse rate at rest, diastolic and systolic blood pressure at the level of significance of 0.01 (p=0.000). Polewalking improved the values of fitness index (FITIND) and maximal oxygen consumption (VO2max) at the level of significance of 0.01 (p=0.000). On final measurement, three variables, i.e. pulse rate at rest – HRR (E=73.42 vs. *C=79.68), systolic blood pressure – BPS (E=118.42* vs. *C=123.65) and diastolic blood pressure – BPD (E=79.04* vs. *C=83.54), showed lower results in experimental group compared with control group. On final measurement, experimental group showed higher values of the FITIND (E=81.79* vs. *C=62.66) and VO2max (E=21.83* vs. *C=16.81) variables as compared to control group. Accordingly, such a moderate physical activity, which is not too vigorous yet intensive enough to induce favorable changes, appears to be recommendable for elderly women. The present study included 60 women from the Novi Sad community, mean age 58.5±6.90 years, mean body mass 70.9±15.32 kg and mean body height 164.8±7.24 cm. Study population was divided into two groups of 30 subjects: experimental (E) group and control (C) group. The experimental program was performed three times a week for three months. The Nordic walking program was so designed for the performers to be in the aerobic work zone throughout the exercise. Nordic walking with poles was performed over three months. Study results revealed functional abilities of the study women to have modified during the longitudinal process.*

Key words: *nordic walking, aerobic training, pulse, elderly women*

Introduction

Nordic walking, also known as polewalking, is a type of recreational walking originating from Finland. It was first applied in 1930, with an increasing popularity ever since. Initially conceived as a method of summer training for the athletes engaged in cross-country skiing and biathlon, Nordic walking has long become a favorable sport event for the population at large in northern countries.

In 1980, clinical studies associated the use of walking poles with fitness elements. Subsequent studies demonstrated this simple but efficient exercise to improve cardiovascular activity, musculature and vitality (Bös, 2004)[1].

Nordic walking is suitable for training intensification, while protecting the joints. With the use of poles, the entire passive locomotor system such as tendons and connective tissue, the back and the joints (knees in particular) is disburdened by approximately 15–35 tons *per* hour. Therefore, Nordic walking is an ideal option as rehabilitation activity for individuals with orthopedic problems.

Currently, this form of recreational walking has numerous followers. The Finnish version of recreational walking is the use of special walking poles. That is why athletes call it »dry land cross-country«.

A Finnish study (Anttila et al., 1999)[2] compared regular walking and Nordic walking performed for 12 weeks in 55 female office workers. Electromyography results showed electrical measurements of muscular activity of the upper part of the body (the neck, shoulders and upper back) to be significantly higher at polewalking. Training induces changes in skeletal musculature, cardiovascular system, respiratory system, endocrine system, etc. Along with knowing the signs of adaptation and provoking factors, it is necessary to upgrade the awareness of the role of adaptation in improving physical abilities. In

Received for publication July 4, 2011

this way, an appropriate recovery process can be achieved with maximal favorable effects and minimal unfavorable health impact (Boyadjiev, 2004)[3].

A study including 17000 Harvard graduates revealed the individuals practicing moderate physical activity on regular basis to have a considerably better overall health condition. Most of them were practicing recreational walking (Tudor-Locke et al., 2006)[4]. Parkkari et al. (2004)[5] assessed the risk of injury in various sports and recreational activities. The study included 3657 Finns aged 15–74. Of all recreational and contest activities, the highest risk of injury was associated with squash (18.3%), followed by judo (16.3%) and orienteering (13.6%). In Nordic walking, the risk of injury was very low (1.7%). Tully et al. report on a significant increase in functional capacity with reduction in systolic and diastolic blood pressure and in the risk of stroke in the group on 12-week walking treatment[6].

Physical inactivity causes atrophy of the musculoskeletal system and is an essential factor related to gaining weight in older age[7]. Osteoporosis, which is the most frequent metabolic bone disease during this period, is associated with an increased risk of fractures[8]. Musculoskeletal pain, physical disabilities and related decline in participation negatively affect the quality of life of menopausal women and poses an important health care issue[9–11].

Studies published to date point to favorable effects of walking on functional capacity and blood pressure in the elderly. The aim of the present study was to analyze the effects of experimental treatment (Nordic polewalking) on functional abilities of elderly women.

Subjects and Methods

Subjects

The study included 60 women from Novi Sad community, mean age 58.5±6.90 years, mean body mass 70.9±15.32 kg and mean body height 164.8±7.24 cm. Study population was divided into two groups of 30 subjects: experimental (E) group and control (C) group. All subjects were enrolled in the study on a voluntary basis. Experimental group included elderly women attending fitness program specially designed for this age group at a recreation center, while control group included 30 randomly selected elderly women.

Treatment

The experimental program was performed three times a week for three months. During the study, the subjects were not engaged in any other physical activity. Control group women performed no physical activity during these three months. Experimental group performed walking exercise by use of Nordic poles. These poles are longer than the usual walking poles and have, like walking and skiing poles, properly designed handles and a metal tip (used on walking on soft ground, preventing pole slipping) or rubber ending (used on walking on road surface and put on the pole tip to prevent pole slipping). Throughout the treatment, correct performance, intensity and volume of exercise were surveyed by fourth-year students of the Faculty of Sports and Physical Education (Recreational Activities). They were informed in detail on the treatment and trained in proper training performance. Prior to each activity, study subjects were informed on the desirable pulse rate during training. The program of walking exercise was so designed for the subjects to be in the aerobic work zone at any moment of training. During walking exercise, heart rate was monitored by use of pulse meter and used to determine load intensity. The program was divided into three parts different by the volume and intensity.

Exercise plan:

Weeks	1–4	5–8	9–12
Volume (min)	15–30	30–40	40–55
Intensity (percent of maximum pulse)	60–65	65–70	75–80

Thus, the exercise program lasted three months, i.e. three trainings *per* week for 12 weeks, making 36 trainings during three-month treatment. Exercise intensity was defined for each subject individually based on heart rate and was enhanced accordingly every month, as illustrated above. Of course, each subject completed the walking distance at different time; however, the point is that the intensity of walking was modified after four weeks. Measurements were performed during break, not on exercise.

Load differences according to age:

Age	Maximum pulse	Heart rate on exercise				
(yrs)	100%	80%	75%	70%	65%	60%
40	180	144	135	126	117	108
45	175	140	131	122	114	105
50	170	136	128	119	110	102
55	165	132	124	115	107	99
60	160	128	120	112	104	96

High load was avoided because elderly people require lower heart rate for aerobic exercise. The values given in the table should be met, therefore there is no need for running when aerobic work can also be achieved by walking, which is by far safer and less demanding.

Optimal loading intensity is dosed at 50% to 90% of maximal heart rate (Adams, 2004)[12]. Loading intensity can be easily determined by using the formula for maximal heart rate calculation according to Earl and Breachle (2004)[13]: 220-years of age. The number thus obtained is the maximal recommended number of heartbeats *per* minute for safe exercise. Then, 60% to 80% of the calculated maximal heart rate is determined, depending on the exercise load to be achieved.

Measurements

Semiautomatic sphygmomanometer (M6 Comfort, Omron) was used on blood pressure measurement. Two-kilometer walking test enables determination of fitness index

(FITIND; general ability) and maximal oxygen consumption (VO2max).

Functional abilities were assessed by the following measurements: heart rate at rest (HRR; bpm); systolic blood pressure (BPS; mm Hg); diastolic blood pressure (BPD; mm Hg); fitness index (FITIND); and VO2max (mL/kg/min).

As study subjects were elderly women where physically demanding tests are not recommended, the UKK 2-km walking test was used. Although engaging large muscle groups, this test does not belong to high-risk activities that may lead to rapid exhaustion of the body. The authors consider it a test with a high level of reliability and simple to perform[14].

Test protocol requires air temperature of 5–25°C, moderate humidity, comfortable clothes or sweat suit, suitable shoes or sports shoes, and 5- to 10-min warming up including musculature of the spine and lower extremities, and 200-m fast walking. These preparatory activities are followed by test performance, where each subject dictates his/her own walking rate. Time and pulse are measured after two kilometers. The UKK Walk Test is performed by walking 2 kilometers/1.24 miles as fast as possible on a flat surface. The result is recorded as FITIND. It is influenced by the subject's age, sex, height, weight, time taken to walk 2 kilometers/1.24 miles, and heart rate at the end of the test. There are five fitness classes that can be used to compare the result with fitness of the others matched by age and sex, or with one's own previous results and development between the tests.

Formula to calculate fitness index for individuals aged 18–65:

Female

$$304–(8.5\ \text{min}+0.14\ \text{sec}+0.32\ \text{HR}+1.1\ \text{BMI})+0.4\ \text{years}$$

Time expressed in minutes and seconds (e.g., 15:30 is separated to 15 minutes and 30 seconds)

HR = pulse within one minute of test completion

BMI = body weight (kg)/square body height (m)

Age (years)

Scoring according to UKK Institute in Tampere, Finland:

Category according to Fitness Index	UKK Fitness Index
Clearly below-average	<70
Slightly below-average	70–89
Average	90–110
Slightly above-average	111–130
Clearly above-average	>130

Formula to calculate maximal oxygen consumption VO2max (mL/kg/min):

Female

$$\text{VO2max}=116.2–2.98\ \text{time}–0.11\ \text{HR}–0.14\ \text{years}–0.39\ \text{BMI}$$

Test time is expressed as follows:

15 minutes and 30 seconds = 15.5 minutes

Subjects should be warned to slow down, stop and take a rest if they experience strong heartbeat, chest pain or nausea during test performance.

Statistical analysis

The SPSS software (SPSS for Windows, version 15.0, SPSS, Chicago, IL, USA) for personal computers was used on statistical analysis.

Multivariate analysis of covariance (MANCOVA) was used to determine the effects of experimental treatment. The reason for the use of MANCOVA was to neutralize (equalize) between-group differences on initial measurement. Upon result neutralization, the real effects of experimental program in particular subject groups were determined. Between-group differences at univariate level with neutralization on initial measurement were assessed by use of univariate analysis of covariance (ANCOVA) using the corrected mean values (M).

Results

The basic descriptive statistics parameters are shown in Table 1 and 2. On initial measurement, control group subjects showed better results than experimental group subjects in all variables, fitness index and heart rate in particular. Most likely, the experimental group subjects were motivated to enroll in the exercise program by their below-average functional abilities, wishing thus to improve these substantial body functions.

In the elderly, the values of 120 mm Hg and 80 mm Hg are considered normal for systolic and diastolic blood pressure, respectively. In the experimental group, the mean systolic blood pressure was 129.83 mm Hg and diastolic blood pressure 84.66 mm Hg, showing a slight increase from normal values. Comparable values were also measured in control group, i.e. 123.30 mm Hg and 82.73 mm Hg.

All FITIND values <70 in the elderly are considered to be far below average. The initial measurement revealed our study groups to have lower than average values of the variables including age, sex, body height, body mass, time achieved and heart action at the end of the test. Comparison of these values with the age- and sex--specific recommended VO2max values (Shvartz & Reibold, 1990[15]; Fletcher et al., 1995[16]) indicated that our subjects had a very low VO2max level.

The aim of the present study was to analyze the effects of experimental treatment on functional abilities of elderly women. Results obtained by multivariate analy-

TABLE 1
DESCRIPTIVE CHARACTERISTICS OF THE SUBJECTS (N=60)

Variable	$\bar{X}$±SD
Body mass (kg)	70.9±15.32
Body height (cm)	164.8±7.24
Age (years)	58.5±6.90

TABLE 2
DESCRIPTIVE STATISTICS OF PERFORMANCE ON INITIAL MEASUREMENT

	$\overline{X}$±SD	Min	Max	Range Max-Min
Experimental group (N=30)				
HRR (bpm)	84.93±12.20	60.00	110.00	50.00
BPS (mm Hg)	129.83±14.74	106.00	160.00	54.00
BPD (mm Hg)	84.66±10.84	64.00	109.00	45.00
FITIND	55.66±16.16	16.31	101.16	84.85
VO2max (mL/kg/min	15.75±4.79	6.21	29.88	23.67
Control group (N=30)				
HRR (bpm)	77.83±9.05	44.00	94.00	50.00
BPS (mm Hg)	123.30±12.66	99.00	156.00	57.00
BPD (mm Hg)	82.73±9.79	47.00	105.00	58.00
FITIND	64.46±15.12	36.69	99.78	63.09
VO2max (mL/kg/min)	16.67±5.40	7.41	30.19	22.77

HRR – heart rate at rest, BPS – systolic blood pressure, BPD – diastolic blood pressure, FITIND – Fitness Index, VO2max – maximal oxygen consumption

sis of covariance of the variables used for assessment of functional abilities yielded a statistically significant difference in these abilities at multivariate level between experimental and control group, at the level of significance of 0.01 (p=0.000) (Table 3).

TABLE 3
MULTIVARIATE AND UNIVARIATE ANALYSIS OF CO-VARIANTS FOR VARIABLES ESTIMATING FUNCTIONAL ABILITIES BETWEEN EXPERIMENTAL AND CONTROL GROUP ON FINAL MEASUREMENT

Wilks	F	df1	df2	p
0.37	9.60	10.00	150.00	0.00
Variable	$\overline{X}$ (E)	$\overline{X}$ (C)	F	p
HRR (bpm)	73.42	79.68	12.12	0.00
BPS (mm Hg)	118.42	123.65	10.32	0.00
BPD (mm Hg)	79.04	83.54	8.96	0.00
FITIND	81.79	62.66	37.14	0.00
VO2max (mL/kg/min)	21.83	16.81	42.24	0.00

HRR – heart rate at rest, BPS – systolic blood pressure, BPD – diastolic blood pressure, FITIND – Fitness Index, VO2max – maximal oxygen consumption

Univariate analysis of covariance of variables assessing functional abilities in experimental and control group produced a statistically significant difference in all variables at the level of significance of 0.01 (Table 3). On final measurement, the first three variables, i.e. pulse at rest (E=73.42<C=79.68), systolic blood pressure (E=118.42<C=123.65) and diastolic blood pressure (E=79.04 <C=8.54), showed lower results in experimental group as compared with control group. The program of exercise led to a decrease in the values of pulse at rest, systolic and diastolic blood pressure in experimental group. On final measurement, the variables of FITIND (E=81.79 >C=62.66) and VO2max (E=21.83>C=16.81) showed higher values in experimental group as compared with control group, reflecting improvement of functional abilities in the former.

Data presented in Table 4 show the test time achieved and pulse rate to be reduced on final measurement in experimental group, while BMI value remained unchanged. As FITIND is a measure of general abilities, and the results showed the body mass to have remained nearly the sameista, changes were only recorded in functional abilities of experimental group.

TABLE 4
DESCRIPTIVE STATISTICS OF PERFORMANCE FITNESS INDEX

		Initial measurement			Final measurement		
	Group	$\overline{X}$±SD	Min	Max	$\overline{X}$±SD	Min	Max
Achieved time (min and sec)	E	24.11±1.79	20.29	28.49	21.99±1.63	19.10	25.10
	C	23.17±1.75	19.45	27.17	22.95±1.78	20.01	27.10
Pulse at test end	E	109.43±16.74	78.00	143.00	102.40±12.28	79.00	120.00
	C	112.57±13.65	82.00	144.00	112.03±12.95	81.00	135.00
Body mass index	E	25.95±3.94	19.50	35.56	25.21±3.92	18.72	34.76
	C	25.59±3.81	18.66	35.11	25.57±3.78	18.62	34.89

Discussion and Conclusion

The three-month training protocol described was the first organized and professionally guided program of Nordic walking in Novi Sad. The aerobic character of this form of physical activity was achieved by the given load monitoring using a pulse meter.

Study results showed the three-month training process to have led to changes in the subjects' functional abilities. Results on each individual variable in experimental and control group are presented in Table 3. On final measurement, the variables of pulse at rest, systolic and diastolic blood pressure showed lower values in experimental group as compared with control group, confirming the effect of polewalking on these variables.

On final measurement, the variables of FITIND and VO2max showed higher values in experimental group as compared to control group, pointing to enhanced functional abilities in the former. This increase manifested as improved FITIND as a measure of general ability and higher VO2max as the best indicator of lung capacity and air intake. Jürimäe et al. (2009)[17] report on Nordic walking as an acceptable exercise for elderly women irrespective of their baseline maximal VO2. Women with low initial VO2 can be recommended to exercise at a lower rate regulated by their own subjective feeling. In contrast, women with high baseline VO2 should use maximal walking rate.

On final measurement, heart rate was lower than either heart rate reported for age-matched subjects in the literature (Leitch et al., 1997[18]; Sweitzer et al., 2002[19]) or those recorded in control groups for particular physical training programs (Kiilavuori et al. (1996)[20], thus confirming favorable results in our experimental group.

Suija et al. (2009)[21] assessed the effects of 24-week Nordic walking. Functional abilities were tested by use of UKK test. Study results showed improved FITIND values, which is consistent with our findings. Other studies of Nordic walking demonstrated the VO2max to be increased in experimental group *versus* control group (Parkatti et al., 2002[22]; Kukkonen-Harjula et al., 2004[23]; Schiffer et al., 2006[24]), which is also consistent with our study.

Nordic walking treatment represents optimal continuity of kinesiologic activity, in middle-aged and elderly women in particular, to maintain and enhance their functional abilities. It is preceded by kinesiologic education of children and adolescents at elementary and secondary school, where the improvement and upgrading of aerobic abilities to a higher level will also influence development of the morphological-motor system, thus improving the whole body function. Appropriate systemic kinesiologic activities will accelerate integration of aerobic abilities in the morphological-motor system (Katić, 2003[25]; Katić et al., 2004[26]; Katić et al., 2004[27]; Katić et al., 2005[28]; Bala et al., 2009[29]; Bala and Katić, 2009[30]). Specifically designed physical training including dance and aerobic programs and rhythmic gymnastics elements in secondary school female fourth-graders will influence development of coordination/agility and specific rhythm coordination, functional aerobic ability, repetitive and explosive strength and flexibility, and will result in considerable overweight and adipose tissue reduction Štalec-Viskić et al. (2007)[31]. The program of regular exercise once a week, designed and led by a physiotherapist, helps improve and maintain flexibility, muscular strength and equilibrium in postmenopausal women (Turk et al., 2010)[32]. Exercise reduces the rate of adverse somatic and vasomotor symptoms of menopause[33]. Regular one-hour walk three to five times a week significantly improves lung capacity, increases oxygen uptake, and decreases the level of body fat[34].

Considering all the beneficial effects of walking and relying primarily on the heart rate, walking will certainly yield favorable results in terms of health condition and disease prevention, with beneficial impact on the cardiovascular system in the elderly. In the present study, the three-month Nordic walking treatment reduced the values of pulse at rest and blood pressure, while improving the values of FITIND and VO2max. The experimental group women were protected from overload and achieved good effects of the exercise program. At this age, women experience problems with elevated blood pressure and heart rate. Thus, such an activity that is not too vigorous, yet adequate to cause beneficial changes can definitely be recommended to elderly women.

The beneficial changes in the indicators of functional ability in elderly women induced by the treatment of Nordic walking were more pronounced than those produced by previous treatments, suggesting that the load level was optimal yet adequate to provoke desirable response, i.e. body adjustment to the dosed stimuli.

Study results indicated that physical activity in the form of Nordic walking contributed to improved functional abilities in elderly women, whereas physical inactivity along with aging processes led to a decline of these functions.

Acknowledgements

The study was supported by grant No. 177-0000000-3410 from the Croatian Ministry of Science, Education and Sports.

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UTJECAJ NORDIJSKOG HODANJA NA FUNKCIONALNE SPOSOBNOSTI I KRVNI TLAK STARIJIH ŽENA

S A Ž E T A K

Cilj rada je bio analiza učinaka nastalih primjenom eksperimentalnog tretmana na funkcionalne sposobnosti žena starije dobi. U toku tri mjeseca vježbalo se hodanje uz upotrebu nordijskih štapova. Na osnovi dobivenih rezultata utvrđeno je da je u toku longitudinalnih procesa došlo do promjene funkcionalnih sposobnosti vježbačica. Tretman nordijskog hodanja u trajanju od tri mjeseca smanjio je vrijednost pulsa u mirovanju, kao i donji i gornji krvni tlak na razini značajnosti od 0,01 (p=0,000). Nordijsko hodanje je poboljšalo i vrijednosti fitnes indeksa (FITIND) te maksimalne potrošnje kisika (VO2max) na razini značajnosti od 0,01 p=0,000). U konačnom su mjerenju tri varijable: puls u mirovanju – HRR (E=73,42 prema C=79,68), sistolični krvni tlak – BPS (E=118,42 prema C=123,65) i dijastolični krvni tlak – BPD (E=79,04 prema C=83,54) pokazale niže rezultate kod eksperimentalne skupine u usporedbi s kontrolnom skupinom. Varijable FITIND (E=81,79 prema C=62,66) i VO2max (E=21,83 prema C=16,81) u konačnom mjerenju pokazale su veće vrijednosti kod eksperimentalne grupe u odnosu na kontrolnu. Upravo ovakva aktivnost koja nije prejaka, a dovoljna je da izazove pozitivne promjene preporučuje se starijim vježbačicama. Istraživanje je obuhvatilo 60 žena iz općine Novi Sad. Uzorak ispitanica je obuhvatio žene prosječne starosti 58,5±6,90 godina, prosječne tjelesne mase 70,9±15,32 kg i prosječne tjelesne visine 164,8±7,24 cm. Vježbačice su bile podijeljene u dvije grupe: eksperimentalnu (E) i kontrolnu (C) s po 30 članica. Eksperimentalni program je trajao tri mjeseca, a aktivnost se odvijala tri puta na tjedan. Program nordijskog hodanja je koncipiran tako da se vježbači u svakom momentu vježbanja nalaze u aerobnoj zoni rada.