CONCURRENT RESISTANCE AND ENDURANCE TRAINING PROGRAMME FOR THE IMPROVEMENT OF PHYSICAL FITNESS IN MIDDLE-AGED OBESE FEMALES

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PROGRAM HKRATNE VADBE MOČI IN VZRDŽLJIVOSTI ZA IZBOLJŠANJE TELESNE PRIPRAVLJENOSTI ŽENSK V SREDNJI DOBI S POVEČANO TELESNO TEŽO

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Abstract

The purpose of the study was to determine the effects of a ten-week concurrent resistance and endurance-training programme for improving physical fitness of middle-aged obese females. Eleven obese (body mass index BMI>27.0 kg/m^2) and 13 control (BMI<27.0 kg/m^2) females participated in the investigation. Three series of anthropometrical measurements were taken according to the O-scale Physique Assessment System. The ratio of waist to hip circumference (WHR) was calculated. Body composition was measured with the bioelectrical impedance method (Bodystat 500, UK). Individual physical working capacity (PWC) was measured with the cycle ergometer test. One repetition maximum leg extension (1RM LE) was used to assess maximal isoinertial strength.

Training sessions were performed three times per week and resistance training consisted of four exercises (leg extension, bench press, sit-ups, leg press). The subjects performed four circuits at maximal possible speed, using a work-to-rest ratio of 60 sec. The 75% 1RM load and 8-12 repetitions per set were used. The duration of resistance exercises was 32 min, which was followed by 30 min of continuous walking at the intensity of ≈75% maximum heart rate.

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Izvleček

Namen študije je bil ugotoviti učinek deset-tedenske hkratne vadbe moči in vzdržljivosti za izboljšanje telesne zmožnosti debelih žensk srednjih let. Enajst debelih žensk (indeks telesne mase BMI>27.0 kg/m^2) in trinajst v kontrolni skupini (BMI<27.0 kg/m^2) je sodelovalo v študiji. Opravljene so bile tri meritve antropometričnih mer glede na »O-scale Physique Assessment System«, iz dobljenih podatkov je bilo izračunano razmerje pas-boki (WHR). Telesna sestava je bila izmerjena z metodo bioelektrične impedance (Bodystat 500, UK), delovna zmogljivost (PWC) pa s testom na bicikel-ergometru. Za oceno maksimalne izometrične moči je bil uporabljen test enkratne maksimalne nožne iztegnitve (1RM LE).

Vadba je potekala trikrat-tedensko. Vadbo moči so predstavljale štiri vaje (iztegnitev noge, potisk s prsi, dviganje trupa in potisk z nogami). Vadeče so opravile štiri serije z največjo možno hitrostjo, ob razmerju vadba-počitek 60 s. Uporabljena je bila obtežitev 75% 1RM in 8-12 ponovitev v seriji. Vadba odpora je trajala 32 min, sledilo je 30 min neprekinjene hoje z intenzivnostjo približno 75% maksimalnega srčnega utripa.

Debele ženske so imele značilno ($p<0.05$) višje kožne gube, obsege in premere. PWC in 1RM LE moč sta tudi bila značilno višja v skupini debelih. WHR je bil značilno negativno povezan z vsemi izmerjenimi indeksi telesne zmogljivosti pri debelih, pri kontrolni skupini pa ne; medtem, ko je neto telesna masa značilno pozitivno povezana z omenjenimi indeksi pri debelih, ne pa tudi pri kontrolni skupini. Telesna teža, odstotek telesne tolšče, količina telesne tolšče in vsota 8SF so se značilno zmanjšale po izvedenem pro-

Obese women had significantly higher ($p<0.05$) values for skin-fold, girth and breadth measurements. PWC and 1RM LE strength was also significantly higher in the obese group. WHR was significantly negatively related to all measured physical fitness indices in obese but not the control subjects. While lean body mass was significantly positively related to all measured physical fitness values in obese but not control subjects. Body weight, body fat %, body fat amount and sum of 8SF were significantly decreased as a result of the training programme in middle-aged obese females. While no significant effects of training programme on body composition characteristics were observed in middle-aged control women. PWC values were significantly increased in both groups studied as a result of training programme. While 1RM LE strength was significantly increased after the training only in control subjects. In conclusion, the concurrent resistance and endurance training programme for the improvement of physical fitness of middle-aged obese females appears to be an acceptable form of physical activity to reduce body weight and increase cardiovascular fitness.

Key words: obesity, females, concurrent training, body weight, cardiovascular fitness

gramu vadbe pri debelih ženskah, medtem ko ni bil opažen značilen vpliv vadbe na telesne značilnosti kontrolne skupine. PWC se je značilno izboljšal pri obeh skupinah, 1RM LE moč pa se je značilno povečala le pri kontrolni skupini. Zdi se torej, da hkratna vadba moči in vzdržljivosti za izboljšanje telesne zmogljivosti predstavlja sprejemljivo obliko telesne aktivnosti za zmanjšanje telesne teže in izboljšanje zmogljivosti srčno-žilnega sistema debelih žensk srednjih let.

Ključne besede: debelost, ženske, kombinirana vadba, telesna teža, zmogljivost, srčno-žilni sistem

Introduction

Body size, proportions, physique and composition are factors, which influence physical fitness (Jürimäe and Jürimäe, 1998; Malina, 1994). It has been demonstrated that a taller stature has advantages over a shorter one in everyday dynamic work activities, as well as in exerting force against an external object. Shorter stature is favoured when human body has to be moved against gravity (Malina, 1994). Furthermore, skin-fold thicknesses are routinely used to estimate body composition and are included in physical fitness test batteries (Jürimäe and Jürimäe, 1998; Malina, 1994).

Obesity appears to be a major coronary heart disease (CHD) risk factor (Donohue, Abbott, Bloom, Reed and Yano, 1987). Furthermore, longitudinal investigations have demonstrated that the preferential deposition of body fat in the trunk region is independently associated with CHD and related mortality (Donohue et al, 1987). Numerous studies have linked sedentary lifestyle to low aerobic power (i.e., physical fitness) and increased risk of CHD and related mortality (Berlin and Colditz, 1990; Powell, Thompson, Caspersen and Kendrick, 1987).

Recommendations of safe modes and risks of exercise depend on the type of exercise and the physical condition of participants. Different exercise sessions have been recommended for the prevention of obesity. Aerobic exercises have mostly been suggested for body weight control. At present, walking seems to be the most popular exercise that is recommended for obese people (DiPetro, 1995). However, there is a lot of data indicating that resistance exercises are also very useful in body weight control, especially when using lighter loads (40-60% of one repetition maximum - 1RM) (Gettman and Pollock, 1981). Circuit weight-training programmes have also been recommended (Gettman, Ayres, Pollock and Jackson, 1978; Gettman, Ward and Hagan, 1982). Gettman et al. (1987) have defined circuit weight-training as performance of several repetitions, using moderate weights in a continuous fashion, moving from one station to another with a minimal rest between the stations. Circuit weight training is also recommended to increase aerobic capacity (Gettman, Ward and Hagan, 1982).

It was hypothesised that concurrent resistance and endurance training programme is an acceptable way to increase aerobic capacity and decrease body weight of obese middle-aged females. Thus, the aim of this study was to investigate the effects of a ten-week concurrent resistance and endurance training programme on the physical fitness parameters of middle-aged obese females.

Methods

Subjects

Eleven obese (body mass index [BMI] > 27.0 kg/m^2) and 13 control (BMI < 27.0 kg/m^2) females participated in this investigation (Table 1). All subjects were pre-menopausal women. They had not participated in a regular exercise programme for at least one year prior to the beginning of the study (exercising less than once per week). None of the subjects was taking any medication and all were free of musculoskeletal or other diseases, based on their medical history. They provided informed written consent for the investigation. The study was approved by the Ethics Committee of the University of Tartu. The anthropometric and fitness parameters were measured before and after ten weeks of concurrent resistance and endurance training programme.

Measurement of anthropometry

The heights (Martin's metal anthropometer) and weights (medical balance scale) of the subjects were measured to the nearest 0.1 cm and 0.05 kg, respectively. Three series of anthropometric measurements on the right side of the body were taken by a trained anthropometrist according to the O-scale physique assessment system (Ward, Ross, Leyland, and Selbie, 1989). The anthropometer had previously shown a test-retest reliability of r > 0.90. The Centurion Kit instrumentation was used (Rosscraft, Surrey, BC, Canada). In total, eight skin-folds, ten girths and two breadths were measured. In addition, the ratio of waist to hip circumference (WHR) was calculated (Lohman, 1988). Body composition was measured using the bioelectrical impedance method (Bodystat 500, UK).

Measurement of fitness

Individual physical working capacity (PWC) was measured using the cycle ergometer test. Three progressive workloads at intensities of 50, 100, and 150 W each, for a period of four minutes were used. Heart rate (HR) was measured at the end of each workload, using Sporttester Polar Vantage NV (Kempele, Finland). Individual PWC was calculated at the level of predicted HR_{MAX} (205-1/2 age) by extrapolation. The 1RM leg extension (LE) was used to assess maximal isoinertial strength of the *quadriceps femoris* muscle. The warm-up for this measurement involved repeated loads approximating 25% of body weight. The initial test load was 30% of body weight, additional 2.5 to 5.0 kg being added after every successful repetition (Abernethy and Jürimäe, 1996).

Training programme

Training was performed three times per week on Mondays, Wednesdays and Fridays for ten weeks. The first part of the training session consisted of four exercises to increase cardiovascular fitness, after a short (about 10 min) warm-up using LE, bench press, sit-ups, and leg-press exercises. The subjects performed four circuits at maximal possible speed, using a work-to-rest ratio of 60 sec. The 75% of 1RM load and 8-12 repetitions per set were used (Abernethy, and Jürimäe, 1996). The duration of the whole resistance programme was 32 minutes. After the resistance exercises, the subjects performed 30 minutes of continuous walking on an indoor track (150 m). The subjects walked at an intensity of ≈75% HR_{MAX} during the walking training session. HR was registered continuously during the whole programme, every five seconds, using the Sporttester Polar Vantage NV (Kempele, Finland). The whole training session was held in the afternoon between 3 p.m. and 6 p.m.

Statistical analysis

Standard statistical methods were used to calculate the mean, standard deviation (±SD) and correlation coefficients. A two-way analysis of variance (ANOVA) was used to test the effects of group and ten weeks of concurrent resistance and endurance training programme for each dependent variable. Significance was set at $p<0.05$. The Scheffe method was used for post hoc analysis when a significant F ratio was found.

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Results

Physical profiles of obese and control subjects are presented in Table 1. The groups were not significantly different in terms of age and height. However, obese women were significantly heavier and had significantly higher values for BMI than the control subjects. Obese women demonstrated also significantly higher values for all skin-fold, girth and breadth measurements (Table 1).

Table 2 presents the body composition characteristics before and after the ten weeks of concurrent resistance and endurance training programme in the obese and control groups. Body weight, body fat %, body fat amount and sum of 8SF were significantly decreased as a result of the training programme. No significant effects of the training programme on body composition characteristics were observed (Table 2).

Changes in physical fitness characteristics of middle-aged obese and control females after ten weeks of training are presented in Table 3. PWC values were significantly increased in both studied groups, as a result of the training programme. The 1RM LE strength was significantly increased, after the training, only for the control subjects. No significant differences after the training programme were observed for obese subjects (Table 3).

Correlational analysis demonstrated that significant relationships are present between the LBM value, the PWC and 1RM LE indices in middle-aged obese females before and after the training programme ($r>0.61$; $p<0.05$). Similarly, WHR was significantly related to both physical fitness items, before and after the concurrent resistance and endurance training only for the obese subjects ($r>-0.58$; $p<0.05$). All other correlations between anthropometric parameters and physical fitness values, before and after the training programme in both groups studied, were not significant ($r<0.31$; $p>0.05$).

Table 1. Mean (±SD) anthropometric characteristics of obese and control groups before the training programme.

Variable	Obese (n=11)	Control (n=13)
Age (yrs)	39.3±5.2	37.2±6.3
Height (cm)	168.2±8.0	167.0±5.5
Weight (kg)	84.7±9.8	64.5±4.9*
BMI (kg/m2)	30.1±3.1	22.5±1.5*
Skinfolds (mm)		
Triceps	28.4±7.5	18.4±5.1*
Subscapular	32.6±10.3	15.1±6.0*
Biceps	18.6±5.5	9.8±2.9*
Suprailiac	35.2±13.8	16.1±8.3*
Supraspinal	26.0±8.3	12.0±5.6*
Abdominal	39.7±13.7	19.4±9.7*
Mid-thigh	42.0±12.0	28.4±7.4*
Medial calf	27.6±9.5	17.7±4.9*
Girths (cm)		
Relaxed arm	32.3±3.5	26.0±1.1*
Flexed arm	33.5±3.6	27.1±1.9*
Forearm	26.4±1.4	23.9±0.5*
Wrist	16.3±0.6	14.0±0.3*
Chest	103.4±6.4	87.7±5.5*
Waist	87.9±5.8	71.5±5.4*
Gluteal	108.3±7.1	96.8±3.3*
Thigh	59.0±5.1	51.5±3.7*
Calf	40.4±2.1	36.3±1.6*
Ankle	23.7±1.5	21.7±1.5*
Breadths (cm)		
Humerus	6.8±0.4	6.3±0.3*
Femur	10.1±0.7	9.3±0.3*

Legend: BMI, body mass index.
* Significantly different from obese group; $p<0.05$.

Discussion

The resistance-training programme has been criticised for a lack of observed cardiovascular benefits (Nagle and Irwin, 1960). However, many investigations have confirmed that resistance training might promote improvements in cardiovascular endurance (Gettman et al, 1982; Pollock and Ewans, 1999). In the present study, the intensity of 75% of 1RM was used in the resistance part of the training session. This has been reported to be the most appropriate initial intensity for the development of strength-endurance (Harris and Holly, 1987). In contrast, Gettman et al. (1978) suggested that intensities greater than 50% of 1RM could not be tolerated by subjects attempting to complete a 22- to 30-min resistance programme. However, all obese and control middle-aged females, who participated in this study, had no problems completing a 32-min resistance training followed by 30-min endurance walking.

The obese subjects performed the 30-min endurance walking session reasonably well. Nobody found walking painful or very tiring. The obese women walked more slowly during the walking training session in comparison with the control subjects. Obese subjects have a lower mechanical efficiency than subjects with normal body weight (Freyscuss and Melhec, 1978). In accordance with the study by Mattson et al. (1997), it was speculated that the obese women in our study were able to tolerate the necessary intensity and duration of walking to achieve beneficial effects. Thus, taken together, the concurrent resistance and endurance training programme for the improvement of physical fitness in middle-aged obese females appears to be an acceptable form of physical activity to reduce body weight and increase cardiovascular fitness.

It is well known that obesity indices (i.e., BMI, WHR, body fat %) have been negatively associated with perceived fitness (Jürimäe and Jürimäe, 1998; Malina, 1994). Many studies have investigated the relationships between aerobic physical fitness and anthropometric obesity indices (Jette, Sidney and Lewis, 1990; Jürimäe and Jürimäe, 1998). For example, in a recent study, Jürimäe and Jürimäe (1998) demonstrated that

Table 2. Body composition characteristics before and after 10 weeks of concurrent resistance and endurance training programme in obese and control groups.

Variable	Obese (n=11)		Control (n=13)	
	Before	After	Before	After
Weight (kg)	84.7±9.8	79.4±6.8#	64.5±4.9*	63.9±6.5*
BMI (kg/m2)	30.1±3.1	28.1±1.9	22.5±1.5*	22.4±1.3*
WHR	0.81±0.05	0.80±0.07	0.73±0.04*	0.73±0.02*
Body fat%	34.6±4.5	31.5±3.8#	21.3±3.7*	20.8±4.2*
Fat (kg)	29.8±8.1	25.0±7.8#	13.2±4.4*	13.1±4.1*
LBM (kg)	54.9±6.5	54.4±5.7	51.3±2.9*	50.8±2.6*
Sum 8SF (mm)	250.1±8.4	233.9±7.5#	136.9±6.2*	132.5±5.7*

Legend: BMI, body mass index; WHR, waist to hip circumferences ratio; LBM, lean body mass; Sum 8SF, sum of triceps, subscapular, biceps, suprailiac, abdominal, mid-thigh and medial-calf skin-folds.
* Significantly different from the corresponding value in obese group; $p<0.05$.
# Significantly different from the corresponding value before the training programme; $p<0.05$.

Table 3. Fitness characteristics before after 10 weeks of concurrent resistance and endurance training programme in obese and control groups.

Variable	Obese (n=11)		Control (n=13)	
	Before	After	Before	After
PWC (W)	225.7±74.1	254.3±65.6#	210.9±44.3	224.1±42.1#
PWC/kg (W/kg)	2.7±0.5	3.2±0.4#	3.3±0.3*	3.5±0.5*#
PWC/LBM (W/kg)	4.1±0.3	4.6±0.3#	4.1±0.2	4.4±0.4#
1RM LE (kg)	51.9±18.3	52.6±17.8	34.9±9.8*	39.8±6.7*#
1RM LE/kg	0.6±0.4	0.7±0.2	0.5±0.2	0.6±0.1#
1RM LE/LBM	0.9±0.2	1.0±0.2	0.7±0.1	0.8±0.1#

Legend: PWC, physical working capacity; 1RM LE, one repetition maximum leg extension isoinertial strength; 1RM LE/LBM, one repetition maximum leg extension isoinertial strength per lean body mass.
*Significantly different from the corresponding value in obese group; $p<0.05$.
Significantly different from the corresponding value before the training

high body fat % substantially reduced muscular endurance of obese women. Improvement in physical fitness increases aerobic capacity, decreases resting heart rate and blood pressure, reduces serum cholesterol and triacylglycerols, and has psychological benefits both for lean and obese people (Gettman et al, 1982; Jette, Sidney and Lewis, 1990).

The results of the present investigation indicated that PWC and isoinertial strength measures were negatively related to the WHR index for obese women, before and after the ten-week concurrent resistance and endurance training programme ($r>-0.58$; $p<0.05$), while no significant relationships between PWC and isoinertial strength indices and WHR value were observed in the control group during training ($r< -0.29$; $p>0.05$). This demonstrates that the higher WHR value of obese women has a negative effect on all measured physical fitness indices. It has been demonstrated that certain anthropometric measurements, specifically those indicating central adiposity, are independently associated with the development of total CHD and related mortality (Donohue, Abbott, Bloom, Reed and Yano, 1987). While fat deposition in the periphery does not appear to result in increased risk for CHD (Despres, Moorjani, Lupien, Tremblay, Nadeau and Bouchard, 1990).

In contrast to the WHR index, the BMI value did not have any negative effect on the measured physical fitness indices in our investigation, for any of the groups studied. This means that an evaluation, not only of the extent of obesity but also of body fat distribution, is very important for middle-aged obese women. Similarly, several investigations have demonstrated that WHR appears to be a higher risk factor than BMI for females (Tanaka, Kakiyama and Takamara, 1995). Moreover, the risk of increased WHR has been reported to be independent of BMI, and of other established CHD risk factors (Bjorntorp, 1992).

In contrast to aerobic fitness items (Jürimäe and Jürimäe, 1998), dynamic strength as measured by 1RM LE was significantly higher for obese women in comparison with age-matched controls in our investigation, over the ten-week training programme (see Table 3). Heavier persons have been reported to possess more muscle mass, and are therefore generally stronger than leaner persons (Malina, 1994). Similarly, obese subjects showed significantly higher LBM than the control subjects in our study (see Table 2). It has been reported in some studies (Forbes and Welle, 1983), that LBM could account for as much as 40% of the excess weight for most obese individuals. LBM was significantly related to physical fitness items in obese subjects, before and after the training programme ($r>0.61$; $p<0.05$). This positive relation reflects the larger body size of fatter persons (Malina, 1994). Possibly, obese women need this higher LBM to move their heavier bodies around during everyday activities.

In summary, the concurrent resistance and endurance training programme had positive effects on body weight and cardiovascular fitness parameters of middle-aged obese females. The results of our investigation also demonstrated that higher WHR values had a significant negative effect on all the measured physical fitness indices. It was concluded that our training programme is an acceptable form of physical activity for middle-aged obese females. However, further physical activity is needed to see more positive changes in cardiovascular fitness and anthropometric parameters for middle-aged obese females.

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ATTITUDES OF THE SLOVENE PUBLIC TOWARD SOME CONTENT-RELATED QUESTIONS CONCERNING SPORTS CULTURE

STALIŠČA SLOVENSKE JAVNOSTI DO NEKATERIH VSEBINSKIH VPRAŠANJ KULTURE ŠPORTA

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Abstract

The objective of the research was to establish, on a representative sample of the adult Slovene population (n=1851), the structure of attitudes toward some questions which to a large extent concern the issues of the development of sports culture in Slovenia. Indeed, it is the public which can decisively contribute to the orientation of sports in a given social environment.

In order to attain as representative an assessment of the opinions of the Slovenes as possible, we used an adjusted quota sample, corresponding to the Slovene population with respect to the place of residence, gender, age, and education. The content of the subject of research was focused on the most acute problems of the development of Slovene sports (assessment of the successfulness of athletes, the method of financing sport, assessment of the quality of sports facilities, assessment of the benefits of sport from the aspect of prevention of pathological social phenomena, assessment of the importance of sports education in making people more interested in following sport, assessment of the cultural diversity of physical education in school from the aspect of the diversity of sports). The data on the attitudes were obtained by means of a survey questionnaire of a closed-ended type in June 1998.

The results showed a high degree of validity consensus of the surveyed sample in the majority of the attitudes. In the individual attitudes, a high bipolarisation of the answers was established. The results of the research confirmed the basic hypothetical assumption, that among Slovenes there is a similar opinion of the majority as regards the assessment of sports achievements, quality of sports facilities, financing of sports, benefits of sports from the aspect of prevention of social pathological phenomena and content orientation of physical education.

Key words: culture of sport, values, attitudes, public opinion

Izvleček

Namen raziskave je bil, na reprezentativnem vzorcu odrasle slovenske javnosti (n=1851), ugotoviti strukturo stališč do nekaterih vprašanj, ki v veliki meri zadevajo problematiko razvoja kulture slovenskega športa. Prav javnost je tista, ki lahko odločilno prispeva k usmeritvi športa v določenem družbenem okolju.

Da bi dosegli čim bolj reprezentativno oceno mnenja Slovencev smo uporabili prilagojeni kvotni vzorec, ki bi ustrezal slovenski populaciji glede na regijo bivanja, spol, starost in izobrazbo. Vsebina predmeta raziskovanja je bila usmerjena na najbolj pereče probleme razvoja slovenskega športa (ocena uspešnosti športnikov, način financiranja športa, ocena kvalitete športnih objektov, ocena koristi športa z vidika preprečevanja socialno patoloških pojavov, ovrednotenje pomena športne vzgoje pri ozaveščanju ljudi za spremljanje športa, ovrednotenje kulturne pestrosti šolske športne vzgoje z vidika različnosti športnih zvrsti). Podatke o stališčih smo pridobili s pomočjo anketnega vprašalnika zaprtega tipa v mesecu juniju 1998.

Rezultati so pokazali visoko stopnjo vrednostnega konsenza anketiranega vzorca v večini stališč. Pri posameznih stališčih je bila ugotovljena visoka polarizacija odgovorov. Rezultati raziskave so potrdili osnovno hipotetično predpostavko, da med Slovenci obstoja večinsko podobno mnenje o vrednotenju športnih dosežkov, kvaliteti športnih objektov, financiranju športa, koristnosti športa z vidika preprečevanja socialno patoloških pojavov in vsebinski usmerjenosti športne vzgoje.

Ključne besede: kultura športa, vrednote, stališča, javno mnenje

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