Effects of Detraining on Physical Fitness and Cardiovascular Variables in Non-institutionalized Elders

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Abstract—The purpose of the present study was to investigate the effects of 2-month detraining on physical fitness and cardiovascular health variables.

37 non-institutionalized elders, which completed 1-year of a multicomponental physical activity program, were reevaluated after a 2-month post-intervention for the detraining period. Habitual physical activity (Baecke questionnaire), physical fitness (Functional Fitness Test), body composition (BMI and waist measure), blood pressure, plasma lipid and glucose concentrations were assessed.

Data demonstrated that detraining significantly affected lower body components and the agility/dynamic balance, while there were significant changes in the cardiovascular variables. Our results indicate that favorable physical activity adaptations were lost within 2-months of detraining. Therefore, elders should follow a long-term and systematic exercise routine throughout life, in order to improve and maintain their physical functions and to ameliorate their cardiovascular condition.

Index Terms—physical fitness; cardiovascular variables; elders; detraining.

I. INTRODUCTION

In developed countries, people aged 65 and older constitute approximately 20% of the population and are the fastest-growing segment of the population (1). Ageing is a complex process involving many variables (e.g. genetics, lifestyle factors, chronic diseases) that interact with one another, influencing greatly the way we age (2).

Previous studies suggest that taking part in a regular exercise program can be an effective way to reduce/prevent a number of functional declines and cardiovascular changes associated with ageing, lifestyle and possible aggravation of chronic diseases (3, 4). In this regard, current guidelines point out the importance of physical activity in maintaining and improving various aspects of cardiovascular function, health and strength training in the attenuation of muscle strength declines associated with normal ageing (5, 6).

Regarding that a number of studies have indicated that both morphologic and functional adaptations can decrease even after short detraining periods (7), it seems of interest to know if the benefits of physical activity programs are maintained when detraining occurs, due to unexpected causes such as, illness, vacation or others. In fact, despite evidence of physiological declines during detraining, there is not enough data suggesting how long the beneficial effects of training are maintained, and how this affects the functional fitness changes following the termination of the physical exercise program in non-institutionalized elders (8).

Moreover, and considering that cardiovascular diseases (CVD) are the major cause of death in elders, sustaining older adults’ ability to live independently as well as reducing blood pressure (BP), plasma lipoprotein lipid profiles and body weight via healthy lifestyle regimes, are very important goals for public health, geriatrics, and gerontology. Although there is sufficient data showing that regular physical activity is associated with improvements in cardiovascular health among older adults (9-11), only few studies, have reported detraining evidence focused on cardiovascular health variables, resembling the effects on functional fitness responses.

Despite evidence of physiological decline during detraining, there is little information regarding the ability of seniors to maintain the beneficial effects of training and there is no consensus or sufficient data to suggest how long they last, and likewise how it affects health and quality of life of the elderly (8, 12). Additionally, several studies point out disagreements about the effect of detraining, indicating that the main factors, that can justify these differences are: the sport practiced, the type of prior training, age of individuals, the time of program termination and the type of evaluation applied (7). Therefore, more information is necessary concerning the effectiveness of physical activity in these variables and to determine the extent of detraining.

II. METHODS

Subjects
This is a longitudinal study of 37 non-institutionalized subjects (5 men; 32 Women) aged 62 to 81 from northeast Portugal randomly assigned from an elders association with 14 men and 77 women. Participants were considered eligible for
inclusion if they had scored 24 or more on the Mini-Mental State Examination (without mental disfunction) (13), with regular multicomponental physical activity practice in the last 1 year (2 times per week , with moderated intensity). Participants were excluded if they had any medical or physical limitations for physical activity participation, such as uncontrolled endocrine and metabolic disorders (including diabetes and dislipidemia), hypertension, symptomatic cardio respiratory diseases, severe renal or hepatic diseases, uncontrolled epilepsy, progressive neurological diseases, chronic disabling arthritis and/or a history of cardiovascular diseases. Assessments for outcome measures were carried out before the study.

Before conducting the study, all participants received a complete explanation of the purpose, risks and procedures of the investigation, and gave their written consent. The investigation was in full compliance with the Helsinki declaration of 1975, as revised in 2004. All methods and procedures were approved by the Scientific Board of the High Nursing School Dr. José Timóteo Montalvão Machado in Chaves, Portugal. Subjects were recruited from 8 long-term care institutions (nursing homes) in the Oporto area (North of Portugal).

Design

The data was assessed by trained investigators, using always the same protocol, in a face-to-face interview that included one physical, clinical and socio-demography evaluation. Baseline data was collected in June and detraining data after 2-months, in September of 2011.

During detraining period, subjects maintained their normal activities of daily living, but none of the subjects participated in any physical activity program. They have been contacted person and systematically in order to control this request.

Measurements

Anthropometrics

First, Body mass index (BMI) measure was used as an estimate of body composition. Body height was measured to an accuracy of 1 cm, with the subject in an upright position with a standard stadiometer. Body weight was measured to the nearest 0.1 kg, with subjects lightly dressed and in stocking feet. BMI was calculated using the standard formula: [mass (kg)/height (m)]². We also measured the waist perimeter, in inches, to have a body composition indicator.

Physical Activity

Baecke questionnaire includes a total of 16 questions classified into three domains: work, sports, and non-sports leisure activity. Each domain has several questions scored on a five-point Likert scale, ranging from never to always or very often. Scoring of the questionnaire in our study followed the original system; work was the mean score among eight occupational questions, sports was the mean score among four sports-related questions, and non-sports leisure was the mean score among four habitual physical activities during leisure time.

Each domain could receive a score from one to five points, thus allowing a total score from three (minimum) to fifteen (maximum). For the two most frequently reported sports activities, specific questions regarding the number of months per year and hours per week of participation were addressed (14).

Physical fitness

Physical fitness was evaluated using the Functional Fitness Test (FFT) (15), that consists of 6 validated items (and one alternative) designed to assess the physical mobility of older adults and include: lower body strength (30-s chair stand), upper body strength (30-s arm curl), aerobic endurance (6-min walk test), lower body flexibility (chair sit-and-reach), upper body flexibility (back scratch test) and agility/dynamic balance (8-ft up-and-go). Full detailed information on test administration and protocols can be found in Rikli & Jones (1999). All test stations were organized in a circuit, and the same conditions were maintained for each test at all testing periods. On the testing days, subjects first completed 8-10min warm-up led by a physical education instructor and then all test items were completed.

Blood pressure

Resting blood pressure (BP) was measured with the Dynmap vital signs monitor (Critikon; GE Medical Systems, Milwaukee, WI), using the right arm. After being 15 minutes at supine rest in a quiet, temperature-controlled room, BP measurements were taken with the subjects seated in an upright position with the arm comfortably placed at heart level. Measurements of the diastolic (DBP) and systolic (SBP) BP s were taken within a 10 minutes break. The average of the 3 measurements for SBP and DBP entered as data. The measurements were performed between 8:00am and 11:00am, by the same investigator. Subjects were deemed to be hypertensive where their SBP was ≥140mmHg, their DBP was ≥90mmHg or they were on current antihypertensive drug treatment (16).

Biochemical analyses

A venous blood sample for biochemical assays was withdrawn from the antecubital vein after an overnight fast for measurement of fasting blood glucose, lipid concentrations (high-density lipoprotein [HDL], low-density lipoprotein [LDL], triglycerides [TRIG], total cholesterol [TC]). Samples were stored at 80°C and analyzed using the cholesterol esterase/oxidise enzymatic method, and triglyceride was analysed using the lipase/glycerol kinase/glycerol phosphate oxidase enzymatic method. HDL was analyzed using the homogeneous polyanion/cholesterol esterase/oxidise enzymatic method. Glucose was analyzed using the hexokinase method. Blood lipids and glucose were measured on an Olympus AU600 auto analyser.

Statistical Analysis
All data is reported as means (±SD). Data was analyzed with SPSS software (version 17.0). The 0.05 level of probability was accepted as significant.

Shapiro-Wilk test was used to ascertain on all variables the normality of data distributions. The delta (Δ) value was calculated via the standard formula: Δ=(posttest value–pretest value)/pretest value).

Pearson correlation was used to determine the relationship between the variables Differences within the group in pre vs post intervention and detraining values were performed by one-way analysis of variance (ANOVA). Scheffe was used for Post-hoc comparisons.

III. RESULTS

Our baseline results showed that physical fitness (Ex: lower body strength= 11.9±2.6; agility/dynamic balance= 7.7±2.5) and cardiovascular health (Ex: glucose= 103.1±27.7; cholesterol= 198.8±44.4) of our elderly was within normal values for the subjects of this age with a physical active lifestyle.

Table 1 also shows that after the detraining period, subjects significantly decrease physical activity levels. The implications of detraining are most evident in the agility/dynamic balance (18.5%) and at the lower-extremity body: body strength (7.4%) and body flexibility (4.3%). In cardiovascular variables, we can observe a significant increase in the glucose (8.4%) and cholesterol (4.9%) levels.

<table>
<thead>
<tr>
<th>TABLE 1 Sample characteristics</th>
<th>Baseline value</th>
<th>Baseline value</th>
<th>Δ value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMI (Kg/m2)</td>
<td>28.9±5.9</td>
<td>30.1±3.6</td>
<td>1.6</td>
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<tr>
<td>Waist (cm)</td>
<td>92.1±7.6</td>
<td>93.9±8.1</td>
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<tr>
<td>Baecke (score)</td>
<td>6.6±1.6</td>
<td>5.8±2.1</td>
<td>-14.1*</td>
</tr>
<tr>
<td>LBS (no. in 30s)</td>
<td>11.9±2.6</td>
<td>11.1±2.7</td>
<td>-7.4*</td>
</tr>
<tr>
<td>UBS (no. in 30s)</td>
<td>13.6±3.1</td>
<td>13.0±3.2</td>
<td>3.6</td>
</tr>
<tr>
<td>LBF (in. from toe)</td>
<td>-1.5±3.3</td>
<td>-2.1±3.5</td>
<td>4.3</td>
</tr>
<tr>
<td>UBF (in. from fingers)</td>
<td>-10.9±10.3</td>
<td>-11.7±9.9</td>
<td>3.6</td>
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<tr>
<td>A/DB (sec.)</td>
<td>7.7±2.5</td>
<td>8.9±2.4</td>
<td>18.5*</td>
</tr>
<tr>
<td>AE (no. in 2 min)</td>
<td>126±34</td>
<td>124±35</td>
<td>-1.5</td>
</tr>
<tr>
<td>Glucose (mg/dl)</td>
<td>103.1±27.7</td>
<td>111.1±28.2</td>
<td>8.4*</td>
</tr>
<tr>
<td>Cholesterol (mg/dl)</td>
<td>198.8±44.4</td>
<td>207.7±44.6</td>
<td>4.9*</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>127±16.5</td>
<td>131±16.6</td>
<td>3.6</td>
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<tr>
<td>DBP (mmHg)</td>
<td>76±11.5</td>
<td>77.8±11.9</td>
<td>2.6</td>
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</tbody>
</table>

SBP- Systolic Blood Pressure; DBP- Diastolic Blood Pressure; LBS- Lower Body Strength; UBS- Upper Body Strength; LBF- Lower Body Flexibility; UBF- Upper Body Flexibility; A/DB- Agility/Dynamic Balance; AE- Aerobic Endurance

*Student test significant p≤0.05.

IV. DISCUSSION

Regarding the effects of detraining, our results demonstrated that the most affected components were lower-extremity body, both strength and flexibility, probably because muscles of the upper extremity are most used, which will result in better physical function (17). We deduce that these may also be explained by the activities performed in the leisure time, morphological differences in the connective and skeletal tissues and hormonal differences (18). According to Misic et al. (2007) (19) muscle function is the most important predictor; flexibility is the secondary predictor of low physical function of lower extremities in the elderly.

In agreement with previous studies (20-22), agility/dynamic balance was the most affected component by detraining, which is important because it is associated with the development of musculoskeletal impairments and the progression of disabilities in the elderly (21).

Training cessation amongst elders is generally associated with the loss of functional ability. In this order, to maintain the training effect, the physical activity should be practiced regularly. In accordance with the actual evidence, to maintain fitness level in elders is required moderate physical activity (twice per week), which too prevent the age-related functional decline and cardiovascular health factor (21). Some studies indicate that the morphological and functional adaptations to training may disappear, even after short periods of detraining (23, 24). Henwood & Traffe (2008) (25) explain that detraining responses in the functional performance may be related to the type, duration and frequency of the pre-training and the activities of daily living during the detraining period.

Without training, levels of strength, flexibility and agility diminish over a period of 12 weeks and go to previous levels of training over a period of 10 weeks to 8 months (25). Comparatively, our elders have kept the benefits of training longer than the elderly in other studies with shorter training (24, 25). According to Fatouros et al. (2005) (12) higher intensity training protocols induce greater gains in strength, as well as in whole body physical function of elders. Moreover, higher intensity training may maintain the gains for longer periods after training ends.

The data also revealed that these elders significantly increased their Glucose (8.4%), cholesterol (4.9%) and blood pressure levels. Although many studies have examined the effects of physical activity on several cardiovascular risk factors, depending on the type, intensity, duration of exercise, participants’ age, functional status and different methodologies...
used to evaluate older population, results are sometimes dispersed. In fact the data available in literature, generally support that elders physically active have better plasma lipoprotein lipid and glucose profiles (26). Nevertheless, some authors carry on that these positive cardiovascular health changes are usually more associated with loss of body weight and dietary fat (27). Considering that our subjects do not change their dietary routine, we can suppose that these changes are associated with the detraining-induced adaptations, contributing to significantly worsen insulin action due to the loss of muscle mass, which results in destabilizing levels of glucose and cholesterol (28). Besides, we also observed BMI increases which are associated with cholesterol changes.

Nevertheless, we should highlight that our participants experienced significant changes in blood pressure levels after this detraining period, which is very important since hypertension, a common disease in older individuals, is associated with an increased incidence of all-cause and cardiovascular disease mortality and morbidity such as, stroke, coronary heart disease, and renal failure (29).

According to Peterson et al. (2006) (6) aerobic training, is also frequently used by elders and has excellent health benefits, increasing cardio fitness and strength, reducing risk factors associated with CVD and metabolic diseases (5). However, to promote and maintain physical health and functional independence, it is also necessary to maintain and increase muscle strength through strength training (30). Mainly, strength training compensate the loss of muscle and bone mass associated with ageing, reducing the risk of fractures and moreover maintaining the functionality and flexibility of postural stability thus reducing the risk of falling.

Regarding the timing of cessation, some studies report an enhancement of the magnitude of detraining in elderly patients between 6 and 12 weeks (21, 23, 24), while other studies report physical fitness in the maintenance of some components, namely in aerobic endurance. Also, the differences in the methodologies applied, does not allow a comparison between the studies. Furthermore, the period prior to the training phase is important as well as the time relationship amongst the training and detraining.

Moreover, the age also seems to affect significantly the gains and losses after cessation of the stimulus, being more favorable in younger subjects (2). For example, in relation to muscle strength, Toraman studies (7, 23) observed that the oldest (> 74 years) showed greater reduction in performance of functional abilities after ending the practice of physical activity, especially over longer periods of detraining than in younger ones.

Similarly, some studies, particularly those that focus on muscle strength, have analyzed the influence of training intensity in the durability of gains after detraining (12). Evidence suggests that higher intensities (> 60% 1RM) promote a more prolonged maintenance of muscle and strength gains also indicate that the magnitude of detraining may be influenced by the type of training performed (free weights, elastic bands, machines), time practice and weekly frequency of prior training (24, 25).

The strongest points of this study included the multiple variables studied (dietary regimens; physical activity patterns, etc), and most importantly the opportunity to extend this 1-year of the structured physical activity program. However, this study has some important limitations, such as the small sample size and weather conditions. The results of this study probably cannot be generalized for this population because there were great individual differences within the elders. Further research is needed to determine whether diet and cardiovascular risk modification ameliorates cognitive and functional decline in elderly people.

V. CONCLUSION

Our data reinforces the idea that the negative effects of detraining reduce the functional capacity and cardiovascular health of the elderly hence contributing to physical frailty and an increased the cardiovascular disease risk factor. Elders who undertake physical activity are typically seeking to maintain or increase their physical performance, prevent disabilities, treat diseases and improve their social life opportunities. Underlying these results, health professionals need more help to promote an active healthy lifestyle.

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