Effects of six weeks of detraining on retention of functional fitness of old people after nine weeks of multicomponent training

N F Toraman, N Ayçeman

Original Article

Functional fitness is defined as having the physical capacity to perform normal everyday activities safely and independently without undue fatigue and includes components such as lower and upper body muscle strength, lower and upper body flexibility, aerobic endurance, and motor agility/dynamic balance. The percentage decline in the functional fitness items is generally consistent with age related declines in physical performance.

Despite studies suggesting that training helps to attenuate the effects of aging on functional fitness, it is not known for how long these beneficial effects are maintained. Detraining often occurs in previously sedentary people who participate in exercise for several weeks or months and then stop. Most studies of detraining in elderly people have participated in exercise for several weeks or months and then evaluated the effects of detraining on functional fitness in young-old (YO, aged 60–73 years) and older (O, aged 74–86 years) subjects, and to determine whether functional fitness responded differently to detraining in these age groups.

METHODS

Participants

Forty two elderly adults were initially recruited to take part in a randomised trial designed to investigate the effects of a nine week exercise training programme on functional fitness and body composition and the age responses to the multicomponent training. Subjects were volunteers who were older than 60 years, healthy, and without serious cardiovascular or musculoskeletal diseases, living independently in a retirement home, performing activities of daily living without mobility aids, and had a standardised mini-mental state examination score > 20. Twenty two subjects were assigned to the YO group (aged 60–73 years), and 20 to the O group (aged 74–86 years). The YO and O groups were randomly subdivided into exercisers and control subjects, who did not exercise. Twelve of the YO group participated in the exercise programme and 10 served as non-exercise control subjects; nine of the O group exercised and 11 were controls.

The elderly subjects provided written informed consent before the training and detraining. Of the 42 subjects in the initial phase of the study, 21 of the exercisers and four of the control subjects volunteered for the detraining study. Because the aim of this study was to investigate the effects of detraining after a training programme, only the values for the exercise group were analysed. All participants had medical clearance to participate in the testing, training, and detraining sessions. Normal activities of daily living were maintained during detraining, but none of the subjects participated in any exercise programme.

Intervention

The first phase of the study has been described in detail elsewhere. Briefly, participants performed aerobic, resistance, and flexibility exercise training under the direct supervision of a research assistant. The training variables in the first week’s aerobic training were: intensity, 50% of heart rate reserve; duration, 20 minutes per session; and frequency, three days a week. After the first week, the aerobic training duration was increased by five minutes and the intensity by 5% of heart rate reserve every two weeks. Dynamic resistance exercises were performed in a circuit, organised as a row of 10 resistance exercise stations. The resistance exercises included:...
Table 1 Changes in functional fitness after training and during detraining in two groups of elderly subjects

<table>
<thead>
<tr>
<th>Measure</th>
<th>Young-old group (n = 12)</th>
<th>Detraining</th>
<th>Old group (n = 9)</th>
<th>Detraining</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Training 2 weeks 4 weeks</td>
<td>6 weeks</td>
<td>Training 2 weeks 4 weeks</td>
<td>6 weeks</td>
</tr>
<tr>
<td>8 foot up and go (s)</td>
<td>Pre- 4.6 (0.8)</td>
<td>4.7 (0.7)</td>
<td>7.1 (0.9)</td>
<td>7.2 (0.9)</td>
</tr>
<tr>
<td>Chair stand (rep)</td>
<td>Pre- 10.0 (1.3)</td>
<td>18.2 (3.1)</td>
<td>10.6 (2.0)</td>
<td>14.6 (2.7)</td>
</tr>
<tr>
<td>Six minute walk (m)</td>
<td>Pre- 482.8 (53.6)</td>
<td>565.8 (53.3)</td>
<td>447.8 (80.4)</td>
<td>477.5 (92.2)</td>
</tr>
<tr>
<td>Chair sit and reach (cm)</td>
<td>Pre- -9.5 (15.1)</td>
<td>1.7 (8.5)</td>
<td>-21.1 (5.4)</td>
<td>-11.8 (8.4)</td>
</tr>
<tr>
<td>Back scratch (cm)</td>
<td>Pre- -107.0 (10.8)</td>
<td>-6.8 (7.9)</td>
<td>-20.6 (6.2)</td>
<td>-15.9 (10.7)</td>
</tr>
</tbody>
</table>

Values are mean (SD). Young-old group, aged 60–73 years; old group, aged 74–86 years.

*p < 0.05, group effect, repeated measures analysis of variance.
†Significant difference between times, p < 0.01.
‡Significant difference v baseline, p < 0.01.
§Significant difference v post-training, p < 0.01.
rep, Number of repetitions.

Statistical analysis

All data were presented as means (SD). Data were analysed using SPSS software (version 10.0). Students’ t test for independent samples was used to compare baseline values between the groups. Two-way, repeated measures analysis of variance was performed to determine changes over time for functional fitness tests. The level of significance was set at 0.05.

Measurements

Both groups were tested before training (pre-training) and every two weeks after training (post-training) and every two weeks. On the test day subjects completed a 10 minute warm up led by an exercise instructor and then completed the senior fitness test items, as validated by Rikli and Jones.

The senior fitness test consists of six assessment items. The back scratch test assesses upper body flexibility. Each subject completed two practice repetitions and one 30 second test trial. The score was the best distance achieved between the extended fingers and the tip of the toe.

The arm curl test assesses upper body strength. Each subject completed two practice repetitions and one 30 second test trial. The score was the total number of circles correctly within 30 seconds. The arm curl test assesses upper body strength.

The chair sit and reach test assesses lower body flexibility. Each subject completed two practice repetitions and one 30 second test trial. The score was the best distance achieved between the extended fingers and the tip of the toe.

The back scratch test assesses upper body flexibility. Each subject completed two practice repetitions and one 30 second test trial. The score was the best distance achieved between the extended fingers and the tip of the toe.

All data were presented as means (SD). Data were analysed using SPSS software (version 10.0). Students’ t test for independent samples was used to compare baseline values between the groups. Two-way, repeated measures analysis of variance was performed to determine changes over time for functional fitness tests. The level of significance was set at 0.05.

Measurements

Both groups were tested before training (pre-training) and every two weeks after training (post-training) and every two weeks. On the test day subjects completed a 10 minute warm up led by an exercise instructor and then completed the senior fitness test items, as validated by Rikli and Jones.

The senior fitness test consists of six assessment items. The back scratch test assesses upper body flexibility. Each subject completed two practice repetitions and one 30 second test trial. The score was the best distance achieved between the extended fingers and the tip of the toe.

The arm curl test assesses upper body strength. Each subject completed two practice repetitions and one 30 second test trial. The score was the total number of circles correctly within 30 seconds. The arm curl test assesses upper body strength.

The chair sit and reach test assesses lower body flexibility. Each subject completed two practice repetitions and one 30 second test trial. The score was the best distance achieved between the extended fingers and the tip of the toe.

The back scratch test assesses upper body flexibility. Each subject completed two practice repetitions and one 30 second test trial. The score was the best distance achieved between the extended fingers and the tip of the toe.

All data were presented as means (SD). Data were analysed using SPSS software (version 10.0). Students’ t test for independent samples was used to compare baseline values between the groups. Two-way, repeated measures analysis of variance was performed to determine changes over time for functional fitness tests. The level of significance was set at 0.05.
RESULTS
The YO group consisted of eight men and four women, and the O group consisted of nine men. Results from the two way, repeated measures analysis of variance indicated a significant main effect for time for the arm curl \(F_{4,76} = 24.28, p < 0.001\), the chair stand \(F_{4,76} = 68.79, p < 0.001\), the up and go \(F_{4,76} = 53.62, p < 0.001\), the back scratch \(F_{4,76} = 18.79, p < 0.001\), the chair sit and reach \(F_{4,76} = 16.58, p < 0.001\), and the six minute walk \(F_{4,76} = 13.58, p < 0.001\) tests. There were significant group effects for the up and go \(F_{1,19} = 4.51, p = 0.047\), chair sit and reach \(F_{1,19} = 8.47, p = 0.009\), and six minute walk \(F_{1,19} = 11.67, p = 0.003\) tests (table 1).

After two weeks of detraining, none of the functional fitness test scores had changed in the YO group compared with immediately after training, whereas in the O group the chair stand and six minute walk test scores were significantly lower \(p = 0.005\) and 0.006 respectively.

Scores on the arm curl \(p < 0.001\) for YO, and \(p = 0.002\) for O), chair stand \(p < 0.001\) for YO, and \(p = 0.001\) for O), up and go \(p = 0.004\) for YO, and \(p < 0.001\) for O), back scratch \(p = 0.001\) for YO, and \(p < 0.001\) for O), chair sit and reach \(p = 0.002\) for YO, and \(p = 0.001\) for O), and six minute walk \(p < 0.001\) for YO, and \(p = 0.002\) for O) tests had declined at between two and four weeks of detraining.

In the YO group, there was significant loss in performance on the chair stand \(p = 0.004\), chair sit and reach \(p = 0.001\), and six minute walk \(p < 0.001\) tests at between four and six weeks of detraining. The chair stand and up and go test scores were significantly lower in the O group after six weeks of detraining than after four weeks of detraining. However, performance in the chair stand test for both groups and in the six minute walk and up and go tests for the YO group remained significantly higher than before training after six weeks of detraining.

To our knowledge, this is the first study to compare the effects of age on the responses of functional fitness to detraining in elderly people. Lemmer et al10 compared young subjects (aged 20–30) with older subjects (aged 65–75) and found that age affected strength changes between 12 and 31 weeks of detraining, with greater decreases in strength in the older subjects than the young subjects. Häkkinen et al10 reported that only minor changes occurred in maximal strength, explosive jumping, and walking performances during three weeks of detraining in middle aged and older people. Ivey et al11 investigated the effects of age on the loss of muscular strength during 31 weeks of detraining and stated that muscle quality remained significantly above baseline levels in young men and women (aged 20–30) and older men and age responses to detraining in elderly people living independently.

The findings show that age affected performance loss on the up and go, six minute walk, and chair sit and reach tests during the six weeks of detraining. There were no significant losses on any of the functional fitness tests in the YO group, but performances in the chair stand and six minute walk tests for the O group had declined significantly from the post-training values after two weeks of detraining. Scores on all of the functional fitness tests declined further between two and four weeks of detraining in both of the groups. In the YO group, the chair stand, chair sit and reach, and six minute walk test scores were significantly lower in the O group and the chair stand and up and go test scores were significantly lower after six weeks of detraining than after four weeks of detraining. However, performance in the chair stand test for both groups and in the six minute walk and up and go tests for the YO group remained significantly higher than before training after six weeks of detraining.

DISCUSSION
This study was designed to evaluate the effects of six weeks detraining on functional fitness in young-old and old people, and age responses to detraining in elderly people living independently.

In the YO group, the chair stand and six minute walk test scores were significantly lower after six weeks of detraining than after four weeks of detraining. However, performance in the chair stand test for both groups and in the six minute walk and up and go tests for the YO group remained significantly higher than before training after six weeks of detraining.

What is already known on this topic
It is known that gains in cardiovascular fitness achieved during training last longer than gains in muscle strength in elderly people. However, no studies have compared the effects of detraining on functional fitness nor whether such effects differ with age in elderly people.

What this study adds
Loss of muscle strength and aerobic endurance begins earlier in the older elderly. Changes in flexibility, agility, and aerobic endurance performances in response to detraining are affected by age in elderly adults. Gains in aerobic endurance last longer in the younger elderly.

Table 2 Within-group and between-group effect sizes after two, four, and six weeks of detraining

<table>
<thead>
<tr>
<th>Test</th>
<th>Effect size</th>
<th>Within YO group</th>
<th>Within O group</th>
<th>Between groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>8 foot up and go</td>
<td>0.1</td>
<td>0.4</td>
<td>0.6</td>
<td>0.4</td>
</tr>
<tr>
<td>Chair stand</td>
<td>0.3</td>
<td>0.4</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Arm curl</td>
<td>0.4</td>
<td>0.5</td>
<td>0.2</td>
<td>0.4</td>
</tr>
<tr>
<td>Six minute walk</td>
<td>0.0</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>Chair sit and reach</td>
<td>0.3</td>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
</tr>
<tr>
<td>Back scratch</td>
<td>0.1</td>
<td>0.2</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

YO group, Young-old group (aged 60–73 years); O group, old group (aged 74–86 years).
(aged 65–75), but not older women. Although the protocols of these previous studies were different from that of our study, our finding that lower extremity strength performances remained significantly higher than before training is consistent with those studies.  It is difficult to explain the discrepancy between the upper and lower body response to six weeks of detraining different from data reported previously. It is possible that the duration of training and the multicomponent nature of the training programme, directed mostly at the lower extremities, used in this study caused more of a detraining induced decrease in the arm curl performance. The duration of training has been suggested to be an important contributing factor to the retention of neuromuscular adaptations once training has ended.  Duration of training was longer and intensity of training greater in the previous studies. Decreased flexibility is significantly associated with the development of musculoskeletal impairments and the progression of disabilities in the elderly. However, the effect of detraining on the retention of flexibility in the elderly has not been adequately dealt with. Our finding of a large between-group effect size for the chair sit and reach test after two and four weeks of detraining suggests different rates of change in the two age groups. These data also imply that even short interruptions in regularly performed exercise may result in complete loss of training induced improvements in flexibility. Various studies have indicated that performance on combined agility/dynamic balance tasks is a predictor of recurrent falling, and physical exercise is an important factor in maintaining agility and balance. The large between-group effect size for the up and go test in our study suggested that agility and dynamic balance differed between the two groups after six weeks of detraining. The YO group retained their recently acquired six minute walk performance after six weeks of detraining, although the six minute walk performance declined to pre-training values in the O group. The different responses between our YO and O subjects may reflect different adaptive processes. Sforzo et al reported that elderly people did not suffer any great impairment in cardiovascular exercise performance after 10 weeks of detraining. However, their training period was longer and the participants were fitter and had fewer medical conditions than our subjects. In summary, the results of this study show that age does influence the changes in agility/dynamic balance, lower extremity flexibility, and aerobic endurance during six weeks of detraining. However, six weeks of detraining does not reverse the gains in aerobic endurance and agility made during a nine week exercise programme in young-old (aged 60–73 years) adults and the gains in lower body strength of young-old and old (aged 74–86 years) people.

ACKNOWLEDGEMENTS
This study was supported by the Akdeniz University Research Foundation (No 20.01.0122.07), the Akdeniz University Institute of Health Science, and Akdeniz University School of Physical Education and Sports. We thank Gülşah Sahin, Vedat ÇetinKayara, and Burak Aglamus for assistance with the conduct of this study. Special thanks go to all the subjects who volunteered.

Authors’ affiliations
N F Toraman, N Ayceman, Akdeniz University School of Physical Education and Sports, Antalya, Turkey

H Yaman
University of Akdeniz, Faculty of Medicine, Department of Family Medicine, Antalya, Türkiye; hakanyaman@akdeniz.edu.tr

Competing interests: none declared

REFERENCES

COMMENTARY
This study evaluates the effect of six weeks of detraining on the fitness of elderly subjects, after a nine week exercise training programme. The subjects were classified as young-old (aged 60–73 years) or old (aged 74–86 years). Functional fitness parameters such as agility/dynamic balance, lower extremity flexibility, and aerobic endurance seem to be influenced by age subgroups in the elderly. Upper extremity strength reverted to pre-training levels after six weeks in both age groups. Flexibility may be lost after a short interruption of the exercise programme. Aerobic endurance, lower body strength, and agility gains in the younger elderly and lower body strength gains in the older elderly did not reverse after a nine week training programme. These findings may encourage older adults to participate more regularly in exercise activities.

www.bjsportmed.com