Once a week is not enough: effects of a widely implemented group based exercise programme for older adults; a randomised controlled trial

M Stiggelbout, D Y Popkema, M Hopman-Rock, M de Greef, W van Mechelen

OBJECTIVES: To determine the effects of gymnastics on the health related quality of life (HRQoL) and functional status of independently living people, aged 65 to 80 years. Gymnastics formed part of the More Exercise for Seniors (MBvO in Dutch) programme, a group based exercise programme for older adults in the Netherlands. It has been widely implemented since 1980.

Design: Randomised controlled trial with pretest and post-test measurements.

Intervention: The exercise programme given by experienced instructors lasted 10 weeks and was given weekly (MBvO1; n = 125, six groups) or twice weekly (MBvO2; n = 68, six groups). The control group (n = 193) was offered a health education programme.

Setting: Community dwelling of older people, with a comparatively low level of fitness as assessed with the Groningen Fitness test for the Elderly.

RESULTS: No significant effects were found on the HRQoL (Vitality Plus Scale, TAAQoL, and RAND-36) and the functional status (Physical Performance Test and the Groningen Activity Restriction Scale). The MBvO group, with a low level of physical activity at baseline, showed the only improvement found on the Vitality Plus Scale (F = 4.53; p = 0.01).

Conclusions: MBvO gymnastics once a week did not provide benefits in HRQoL and functional status after 10 weeks. However, participants with a low level of physical activity may benefit from MBvO gymnastics if they participate twice a week. To improve the health of the general public, sedentary older adults should be recruited and encouraged to combine MBvO with the health enhancing physical activity guidelines.

METHODS

This section and the result section are ordered following the criteria of the CONSORT statement for reporting randomised trials.

Design

The study was a multicentre randomised controlled trial, with a cross over design and pretest and post-test evaluations. Subjects were randomised to an experimental group and a control group. The participants in the experimental group were divided into two groups participating once a week (MBvO1), or twice a week (MBvO2). The control group received a health education programme. The trial was designed to detect a minimum difference in effect size of 0.25–0.30 with 80% power at α = 0.05. According to this calculation 360 participants were needed (180 in the experimental group and 180 in the control group). Randomisation took place before baseline measurements were taken. In the second phase, after the post-test evaluation, the control group was also offered either one of the two exercise programmes and the experimental group was offered the health education programme. The medical ethics testing committee of both TNO Prevention and Health and the University of Groningen approved the study protocol.

Abbreviations: MBvO, More Exercise for Seniors; HRQoL, health related quality of life; PPT, Physical Performance Test; GARS, Groningen Activity Restriction Scale
Recruitment procedure and study population

The Groningen Active Living Model (GALM) was used to recruit subjects. About 4600 older adults—selected at random from the municipal registers of the cities of Emmen, Leiden, and Roden (in the Netherlands)—received a written invitation for a screening procedure and were visited at home by a member of the local project team. Door to door approaches have been shown to increase participation in previous studies. During this visit, potential participants were screened using a short questionnaire based on the criteria of the public health recommendations for physical activity. People who were not sufficiently active according to these criteria and who met the inclusion criteria (that is, age 65 to 80 years and living independently) were invited to participate in a fitness test. In total 721 subjects participated in this test, which consisted of a performance based fitness test (Groningen Fitness test for the Elderly) and a health appraisal questionnaire (PAR-Q) applied to identify participants for whom exercise might be risky. The subjects whose test scores were below the median on the walking endurance test were invited to participate in the trial. To compensate for the expected drop out, 26 extra participants were invited. Figure 1 shows a flow chart of the study. Written informed consent was obtained from each subject.

Intervention

MBvO1 participants followed the exercise class once a week and MBvO2 participants twice a week. All exercise sessions took place at a community centre. The sessions for both groups were comparable regarding the type of exercise, duration, and intensity. The intervention lasted 10 weeks. Each exercise class consisted of 10–18 participants and each exercise session lasted 45 minutes and consisted of three stages: 5 minutes warm up, 35 minutes of light aerobic exercises, mainly muscle strengthening exercise and exercises aimed at improving coordination, followed by a five minute cool down period. The lessons took place in a gymnasium and were supervised by a trained and experienced instructor. At the end of each exercise session, participants drank a cup of coffee together as a social event.

The control group followed a health education programme designed to provide attention, social interaction, and health education on lifestyle aspects (excluding information about the benefits of physical activity, exercise, and nutrition). Participants were assigned to groups of 15–25 persons. During the intervention period control group participants received a monthly 1.5 hour education session led by a trained instructor.

Assessment of HRQoL and functional status

Trained interviewers interviewed the subjects to assess HRQoL and functional status. Pretest and post-test interviews were held at the subjects own home (in Leiden) and at two municipal facilities (in Emmen/Roden).

Three instruments were used to measure HRQoL, namely the Vitality Plus Scale (VPS), the RAND-36, and the TNO

---

**Key points**

- More exercise for seniors (MBvO) is the most widely implemented exercise programme for older adults in the Netherlands, usually offered once a week.
- For benefits of functional status and health related quality of life, once a week participation is insufficient.
Leiden Academic Hospital Adult Quality of Life questionnaire (TAAQOL). The RAND-36 is a multi-dimensional health questionnaire, which has been translated into Dutch. It consists of nine subscales. In this study five subscales were used: vitality (reliability: Cronbach’s α 0.821), pain (Cronbach’s α 0.88), mental health (Cronbach’s α 0.85), general feeling of health (Cronbach’s α 0.81), and change in health status (α 0.81). The TAAQOL measures health problems in relation to the way people experience these as problems. The TAAQOL was developed specifically for adults to measure the effects of interventions. It consists of 12 dimensions, which may also be used separately. The subscales social contact (reliability: Cronbach’s α 0.85) and cognition (Cronbach’s α 0.87) were used. Functional status was evaluated with the short form (7 item scale) Physical Performance Test (PPT; Cronbach’s α 0.79). The PPT consists of seven tasks of daily living.

Subjective functional independence was measured with the Groningen Activity Restriction Scale (GARS). The GARS consists of 18 questions about daily activities, and the subtests provide information on the level of difficulty a person experiences in care taking and household activities.

Table 1A Background characteristics of subjects at randomisation

<table>
<thead>
<tr>
<th>Variables</th>
<th>MbvO1 (n = 98)</th>
<th>MbvO2 (n = 53)</th>
<th>Control group (n = 126)</th>
<th>Total (n = 277)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean age in years (y, SD)</td>
<td>71.6 (4.0)</td>
<td>71.5 (4.1)</td>
<td>70.3 (4.0)</td>
<td>71.0 (4.1)</td>
<td>0.05*</td>
</tr>
<tr>
<td>BMI (kg/m², SD)</td>
<td>27.1 (3.5)</td>
<td>26.8 (3.6)</td>
<td>28.0 (4.1)</td>
<td>27.4 (3.8)</td>
<td>0.11*</td>
</tr>
<tr>
<td>Gender (% n)</td>
<td>30% (29, 45)</td>
<td>24% (24, 40)</td>
<td>40% (50)</td>
<td>37% (103)</td>
<td>0.12</td>
</tr>
<tr>
<td>Married (living together)</td>
<td>77% (75, 72)</td>
<td>66% (38)</td>
<td>66% (83)</td>
<td>71% (196)</td>
<td>0.49†</td>
</tr>
<tr>
<td>Unmarried (living together)</td>
<td>1% (1)</td>
<td>1% (1)</td>
<td>1% (1)</td>
<td>1% (2)</td>
<td>0.2</td>
</tr>
<tr>
<td>Divorced</td>
<td>3% (3)</td>
<td>2% (1)</td>
<td>2% (1)</td>
<td>3% (2)</td>
<td>0.7</td>
</tr>
<tr>
<td>Widowed</td>
<td>17% (16, 26)</td>
<td>26% (14)</td>
<td>26% (32)</td>
<td>23% (62)</td>
<td>0.2</td>
</tr>
<tr>
<td>Living alone</td>
<td>2% (2)</td>
<td>5% (6)</td>
<td>5% (6)</td>
<td>3% (8)</td>
<td>0.8</td>
</tr>
<tr>
<td>Level of education (% n)</td>
<td>high</td>
<td>5% (5)</td>
<td>8% (10)</td>
<td>8% (22)</td>
<td>0.99†</td>
</tr>
<tr>
<td></td>
<td>middle</td>
<td>41% (40, 43)</td>
<td>41% (22)</td>
<td>41% (113)</td>
<td>0.99†</td>
</tr>
<tr>
<td></td>
<td>low</td>
<td>54% (52)</td>
<td>51% (24)</td>
<td>64% (140)</td>
<td>0.34†</td>
</tr>
<tr>
<td>Housing situation (% n)</td>
<td>multi-storey house</td>
<td>66% (64)</td>
<td>51% (27)</td>
<td>62% (77)</td>
<td>0.34†</td>
</tr>
<tr>
<td></td>
<td>apartment building</td>
<td>33% (32)</td>
<td>37% (26)</td>
<td>38% (46)</td>
<td>0.19</td>
</tr>
<tr>
<td></td>
<td>service flat</td>
<td>1% (1)</td>
<td>2% (2)</td>
<td>1% (1)</td>
<td>0.3</td>
</tr>
</tbody>
</table>

*Kruskal-Wallis one way analysis of variance (with Tukey b test; corrected for smoking.

Table 1B Lifestyle characteristics of subjects at randomisation

<table>
<thead>
<tr>
<th>Variables</th>
<th>MbvO1 (n = 98)</th>
<th>MbvO2 (n = 53)</th>
<th>Control group (n = 126)</th>
<th>Total (n = 277)</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physical activity (index, SD)</td>
<td>13.6 (3.3)</td>
<td>13.6 (3.3)</td>
<td>13.6 (3.3)</td>
<td>13.6 (3.3)</td>
<td>0.72*</td>
</tr>
<tr>
<td>Sports activities‡</td>
<td>3.33 (3.79)</td>
<td>4.36 (4.98)</td>
<td>3.71 (4.87)</td>
<td>3.70 (4.54)</td>
<td>0.42*</td>
</tr>
<tr>
<td>Smoking (% n)</td>
<td>% n</td>
<td>% n</td>
<td>% n</td>
<td>% n</td>
<td>0.027†</td>
</tr>
<tr>
<td>yes</td>
<td>10% (10)</td>
<td>11% (11)</td>
<td>11% (14)</td>
<td>13% (33)</td>
<td>0.53</td>
</tr>
<tr>
<td>no, formerly yes</td>
<td>41% (40)</td>
<td>53% (28)</td>
<td>55% (69)</td>
<td>50% (137)</td>
<td>0.13</td>
</tr>
<tr>
<td>no, never</td>
<td>49% (47)</td>
<td>26% (14)</td>
<td>34% (42)</td>
<td>38% (103)</td>
<td>0.13</td>
</tr>
<tr>
<td>Alcohol (% n)</td>
<td>yes, maximal 5 glasses weekly</td>
<td>39% (38)</td>
<td>34% (18)</td>
<td>35% (44)</td>
<td>36% (100)</td>
</tr>
<tr>
<td>yes, 6-10 glasses weekly</td>
<td>17% (16)</td>
<td>23% (12)</td>
<td>17% (21)</td>
<td>18% (49)</td>
<td>0.49</td>
</tr>
<tr>
<td>yes, 11-21 glasses weekly</td>
<td>4% (4)</td>
<td>11% (6)</td>
<td>9% (9)</td>
<td>7% (19)</td>
<td>0.19</td>
</tr>
<tr>
<td>yes, more than 21 glasses weekly</td>
<td>1% (1)</td>
<td>2% (2)</td>
<td>2% (2)</td>
<td>3% (8)</td>
<td>0.3</td>
</tr>
</tbody>
</table>

*Kruskal-Wallis one way analysis of variance (with Tukey b test; corrected for smoking.

Background information on age, gender, marital status, housing situation, and education was obtained during the interview. Body weight and height were measured. Body mass index (BMI) was calculated by dividing weight (in kilograms) by the square of height (in m²).

Physical activity was measured using a questionnaire especially designed for use in older people (Spearman correlation with objective measures: r = 0.89). The questions cover three areas, namely, household activities (mean score of 10 items), sports activities (intensity, hours per week, and period of the year for two sports maximum), and leisure time activities (such as knitting, sewing, and reading; intensity, hours per week, and period of the year, six activities maximum). Walking, cycling, and gardening were regarded as sports activities. For the purpose of this study only the household and sports activity questions were used. The sports activity score was calculated by using a formula with weight for intensity, hours per week, and months per year (this is explained in more detail in Voorrips et al, resulting in an index from zero to ℓ (level of physical activity by Voorrips et al for a research group of 29 older adults is 13.6 ± 6.8 (min 1.2–max 31.4).

Other lifestyle components included in the questionnaire were drinking alcohol and smoking. Chronic diseases were characterised using the list of chronic diseases used in the national health survey.

www.jech.com
**Statistical analyses**

**Assignment**
All participants were allocated to the experimental or control condition at random. The intervention group participants were divided into two groups: MBvO1 (participating once a week) and MBvO2 (participating twice a week). Participants who were not willing or able to participate twice a week were permitted to participate once a week.

**Analyses**
The analyses were carried out in two stages. In the first stage, the randomised groups were analysed, with the exercise groups MBvO1 and MBvO2 being combined to form one exercise group score. In the second stage, the analyses were carried out for the two experimental groups (MBvO1 and MBvO2) separately. Descriptive statistics (Kruskal-Wallis one way analysis of variance with Tukey β for interval data and χ² tests for nominal data) were used for the background data. Repeated measures analysis of variance was used to test for significant time x group interactions between the experimental group and control group and between the three groups (MBvO1, MBvO2, and the control group) at a 0.05 level of significance (two sided). If there was a difference between groups on specific parameters at baseline, the level of significance (two sided). If there was a difference between the means of the experimental and the control group, by a sample size weighted average of the standard deviations of the scores in the two groups. An effect size of 0.2 is regarded as a small effect, 0.5 as a medium sized effect, and 0.8 as a large effect. Statistical analysis was performed with the Scientific Package of Social Sciences (SPSS) version 10.0.

**Blinding**
Data were collected by trained staff, blinded to the treatment assignments. During the fitness tests, and the interviews, the participants were requested not to mention to which group they were assigned.

**RESULTS**
In total, data for 277 participants were analysed (fig 1). A total of 109 of the participants dropped out during the 10 weeks (fig 1).

**Background variables**
There was a small—but significant—difference in age between the experimental group and the control group (table 1A). However, age was not associated with the outcome variables and was therefore not used as covariate. There were no differences between the MBvO groups and the control group for BMI, gender, marital status, the level of education, and the housing situation at baseline (table 1A).

**Lifestyle factors**
There were no differences in the level of physical activity between the experimental group(s) and control group at baseline (table 1B). There were significantly more smokers in

---

**Table 2** Summary of the RAND-36 items, TAAQOL and Vitality Plus Scale, the GARS and the Physical Performance Test (PPT 7-items) (means and standard deviations) for MBvO1, MBvO2 and control group

<table>
<thead>
<tr>
<th>Variables</th>
<th>MBvO1 Pretest (n = 98)</th>
<th>MBvO1 Post-test (n = 98)</th>
<th>MBvO2 Pretest (n = 98)</th>
<th>MBvO2 Post-test (n = 98)</th>
<th>Control group Pretest (n = 126)</th>
<th>Control group Post-test (n = 126)</th>
<th>F</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitality</td>
<td>70.1 (17.5)</td>
<td>71.2 (18.2)</td>
<td>70.0 (18.5)</td>
<td>68.3 (18.0)</td>
<td>67.8 (17.9)</td>
<td>0.067</td>
<td>0.51</td>
<td></td>
</tr>
<tr>
<td>Pain</td>
<td>77.3 (21.7)</td>
<td>79.8 (20.4)</td>
<td>85.4 (17.5)</td>
<td>83.6 (21.8)</td>
<td>81.0 (19.9)</td>
<td>0.97</td>
<td>0.38</td>
<td></td>
</tr>
<tr>
<td>Mental health</td>
<td>77.1 (15.0)</td>
<td>77.1 (16.4)</td>
<td>80.0 (13.3)</td>
<td>77.9 (17.8)</td>
<td>76.8 (17.9)</td>
<td>0.93</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>General feeling of health</td>
<td>63.8 (17.7)</td>
<td>63.4 (16.0)</td>
<td>63.9 (16.0)</td>
<td>63.9 (15.7)</td>
<td>63.3 (15.0)</td>
<td>0.01</td>
<td>0.99</td>
<td></td>
</tr>
<tr>
<td>Change in health status</td>
<td>47.7 (21.2)</td>
<td>49.0 (19.2)</td>
<td>50.5 (18.7)</td>
<td>49.5 (14.3)</td>
<td>50.8 (18.6)</td>
<td>0.59</td>
<td>0.56</td>
<td></td>
</tr>
<tr>
<td>TAAQOL scales</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social contacts</td>
<td>86.3 (17.5)</td>
<td>83.4 (19.2)</td>
<td>83.6 (16.9)</td>
<td>80.2 (18.6)</td>
<td>86.4 (17.8)</td>
<td>0.53</td>
<td>0.59</td>
<td></td>
</tr>
<tr>
<td>Cognition</td>
<td>75.8 (22.3)</td>
<td>74.8 (23.0)</td>
<td>78.2 (23.0)</td>
<td>77.0 (22.5)</td>
<td>75.8 (22.1)</td>
<td>0.91</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>Vitality Plus Scale</td>
<td>39.32 (6.31)</td>
<td>39.9% (6.53)</td>
<td>39.55 (6.54)</td>
<td>40.38 (7.06)</td>
<td>39.54 (6.54)</td>
<td>0.69</td>
<td>0.50</td>
<td></td>
</tr>
<tr>
<td>Functional status</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GARS</td>
<td>20.23 (3.68)</td>
<td>20.12 (3.16)</td>
<td>19.81 (3.75)</td>
<td>19.31 (2.63)</td>
<td>20.15 (3.66)</td>
<td>1.09</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td>PPT-7 score (0–28)</td>
<td>24.24 (2.82)</td>
<td>25.33 (1.94)</td>
<td>24.75 (2.48)</td>
<td>25.43 (1.43)</td>
<td>24.31 (2.87)</td>
<td>2.65</td>
<td>0.07</td>
<td></td>
</tr>
</tbody>
</table>

---

**Table 3** Summary of health related quality of life outcomes for intervention and control groups by Vitality Plus Scale for the least physically active population

<table>
<thead>
<tr>
<th>Variables</th>
<th>MBvO1 Baseline (n = 98)</th>
<th>MBvO1 Post-test (n = 98)</th>
<th>MBvO2 Baseline (n = 98)</th>
<th>MBvO2 Post-test (n = 98)</th>
<th>Control group Baseline (n = 126)</th>
<th>Control group Post-test (n = 126)</th>
<th>F</th>
<th>p Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitality Plus Scale</td>
<td>39.11 (7.08)</td>
<td>39.04 (7.43)</td>
<td>37.09 (7.15)</td>
<td>40.00 (6.97)</td>
<td>38.92 (6.81)</td>
<td>38.73 (6.79)</td>
<td>5.36</td>
<td>0.01*</td>
</tr>
</tbody>
</table>

*There is a difference between MBvO2 and MBvO1 and control group: post hoc test Tukey β: p<0.05. The least active group are people who scored under the median of the Voorrips scale at baseline (median=4.10)
Effects of more exercise for older adults

MBvO2 (21%) than in both MBvO1 (10%) and the control group (11%). Because smoking may bias the effects of the exercise programme, an analysis was carried out to assess which outcomes were associated with smoking, and if so smoking was used as a covariate.

There were no differences between the MBvO group(s) and the control group in relation to alcohol consumption (table 1B).

Adherence rate
MBvO1 subjects participated in the intervention on average 8.9 times and the MBvO2 subjects on average 17.8 times (adherence rate 89% in both groups).

HRQoL and functional status
No significant differences were found between time x group (that is, the MBvO1 + MBvO2 group compared with the control group) in the categories of HRQoL, functional status (PPT), and subjective functional status (GARS). No significant differences were found between the MBvO1 and MBvO2 group that were analysed separately compared with the control group (table 2).

In the subgroups with a level of physical activity below the median at baseline, a significant improvement was found in the MBvO2 group on the Vitality Plus Scale (p = 0.01, Cohen effect size 0.18), compared with both the MBvO1 and control groups (table 3). No statistically significant effects were found for any other HRQoL parameters or for functional status in this sub group.

DISCUSSION
This study examined the effects of the widely implemented MBvO gymnastics programme on HRQoL and functional status of independently living older adults aged 65–80 years. People who participated once a week, the normal MBvO regimen, did not show improvement on any of the outcome measures after 10 weeks of exercise. However, in people whose physical activity was below the median at baseline, a significant improvement was found in HRQoL, but not in functional status.

Very few studies have evaluated the effects of community based exercise programmes in this age group. Most studies were carried out in clinical settings or were aimed at people with specific chronic diseases.19–22

Myers and Hamilton22 evaluated the Canadian Red Cross Society’s Fun and Fitness Programme on the social and cognitive functioning of independently living older adults. Although the authors concluded that the exercise programme was well suited for healthy inactive older adults, once a week participation without additional regular physical activity did not improve the outcome parameters. Our study provided similar results and it seems valid to conclude that participation in MBvO-gymnastics once a week only is not sufficient to improve HRQoL and functional status in the short term. This indicates that the organisations responsible for MBvO in the Netherlands should endeavour to promote participation of MBvO at least twice a week. If this provides organisational problems—that is too few staff or insufficient adequate accommodation—MBvO participants should be encouraged to combine participation in regular MBvO classes with compliance to the health enhancing physical activity guidelines1 (HEPA: “…. at least 5 days a week participation in minimum of 30 minutes of moderate physical activity daily”).

Hopman-Rock and Westhoff25 carried out a community intervention trial to evaluate the effectiveness of “Ageing Well and Healthily”—an exercise promotion programme in the Netherlands for older adults aged 65 years and older that lasted six weeks and contained group based health education and a low intensity exercise programme. The authors found an improvement in vitality and subjective health (measured by the RAND-36) after six weeks. However, at baseline the participants in this programme had a lower physical activity score than the MBvO population in our study and subjects continued the exercises at home for three to four times a week. The results of our study and the results of other studies confirm the theory that short term health effects of low to moderate intense exercise are more likely to be reported by the least physically active older population, because sedentary people are expected to benefit most from increasing their level of physical activity.

The protocol finally used may have caused methodological bias after randomisation. A substantial number of older adults refused to participate when they were expected to follow the MBvO gymnastics twice a week. We did not carry out an intention to treat analysis. However, at baseline the only difference between MBvO1 and MBvO2 was smoking behaviour. It may be speculated about the wish of smoking MBvO2 participants to improve their health as quickly as possible.

Studies with short term follow up have certain limitations. Older participants may take several weeks to adapt to the initial rigour of training and need a longer adaptation period to gain the optimal benefit from an exercise programme.26 This may explain why MBvO had no effect on the HRQoL and functional status. However, it is very difficult to carry out a randomised controlled intervention in the general population over a longer period of time because it is difficult to recruit a control group who are not offered the intervention as well.

De Greef et al27 carried out a process evaluation study to compare whether the MBvO-gymnastics classes in our study were comparable to the regular MBvO gymnastics classes in the Netherlands, as evaluated by Klijnstra-Rooks.28 On the basis of this evaluation, it was discovered that the participants in our study had opinions about the characteristics of the exercise programme comparable to those of the participants of the regular MBvO classes. It can be concluded from this comparison that the MBvO classes offered in this study are ecologically valid, and that consequently the results of our study can be generalised to regular MBvO gymnastics classes in the Netherlands.

ACKNOWLEDGEMENTS
We would like to thank Professor H C G Kemper and Professor W L Mosterd for their role in the advisory committee for this project, J Radder, and E C P M Tak, MA, for statistical support, and Mrs M Henzen, Mrs M Wulp, MSc, Dr G Kroes (MA; Netherlands Institute for Sports and Physical Activity), Mrs W Vos (SportDrenthe), and Mrs I Jansen (Sportraad Zuid-Holland) for their organisational assistance.

Authors’ affiliations
M Stiggelbout, M Hopman-Rock, TNO Prevention and Health, Leiden, Netherlands
D Y Popkema, M de Greef, Institute of Human Movement Sciences, University of Groningen, Netherlands

www.jech.com
W van Mechelen, Department of Social Medicine, and Institute for Research in Extramural Medicine, VU Medical Centre, Amsterdam, Netherlands
M Hopman-Rock, W van Mechelen, Body@Work Research Center Physical Activity, Work, and Health TNO-VU, Netherlands

Funding: we would like to acknowledge the Netherlands Health Research and Development Council (ZonMw), The Hague, the Netherlands, for funding this study (grant nr 2200.0062).

Conflicts of interest: none declared.

REFERENCES