A home-based, transtheoretical change model designed strength training intervention to increase exercise to prevent osteoporosis in Iranian women aged 40–65 years: a randomized controlled trial
Kambiz Karimzadeh Shirazi1*, Louise M. Wallace2, Shamsaddin Niknami1, Alireza Hidarnia1, Giti Torkaman3, Mollie Gilchrist4 and Soghrate Faghihzadeh5

Abstract

Physical activity (PA) helps to prevent osteoporosis, but older women are often sedentary. This study used a pre–post randomized controlled design to evaluate a 12-week exercise education intervention program based on the stages of change (SoC) and processes of change from the transtheoretical change model (TTM) to improve adherence with strength and balance training recommendations at levels sufficient to prevent osteoporosis in Iranian women aged 40–65 years. The home-based exercise prescription consisted of strength and balance training that was progressive, individually tailored and included a walking program. Individuals in the training group (n = 61) had a positive, significant progression in psychological SoC (P < 0.001), whereas no progression in stages occurred in the control group (n = 55). After the intervention, the training group demonstrated significant improvements in PA, lower body muscle strength, static and dynamic balance, with no significant changes in the control group. These results support the applicability of the TTM for a PA intervention and indicate that this training program is very effective in improving balance and lower body strength in older women.

Introduction

Osteoporosis is a chronic debilitating disease, characterized by age-related decreases in bone mass [1]. It has been estimated that ~200 million women are affected worldwide [2]. The results of the national program for prevention, diagnosis and treatment of osteoporosis in Iran have revealed that >70% of women and 50% of men over the age of 50 years suffer from osteoporosis or osteopenia, which makes this a very important public health priority for Iran’s health system [2]. Epidemiological and experimental exercise studies, in turn, indicate that physical activity (PA) and regular bone loading exercise are crucial in improving and maintaining bone mass and strength, and so preventing osteoporotic and fall-related fractures [3, 4]. The benefits of strength training include increased muscle and bone mass, muscle strength, flexibility and dynamic balance [5]. A cross-sectional study showed that no citizens >55 years old in a province of Iran were achieving the minimum requirements of PA (defined as exercise at least three times per week for 20 min at moderate intensity or higher) [6]. Another study in Iran showed that only 6% of female nurses reported
regular exercise at the required levels [7]. Also there are some cultural barriers to Iranian women exercising in public places. There are few woman-only fitness centers, which few can afford, and there is an expectation that women will prioritize household responsibilities. There is a need for research to establish effective ways of helping older women to develop healthy and sustainable exercise habits.

The use of a behavioral theory, such as transteoretical change model (TTM) to develop effective interventions in the exercise domain has been reported extensively [8–11]. The TTM has been described as an integrative and comprehensive model of behavior change that has drawn from all major theories of psychotherapy [12]. The stages of change (SoC) dimension of TTM is the temporal dimension identifying the ‘when’ part of the change equation. The processes of change (PoC) dimension of TTM involves understanding ‘how’ individuals change their behavior. This includes cognitive, affective, evaluative and behavioral strategies that an individual may use to modify the problem behavior [13, 14]. Table I defines each of the 10 PoC as it applies to PA (below). Research has demonstrated that an integration of the stages and PoC can provide a useful guide for PA interventions [15].

The education and exercise prescription intervention was tailored to SoC using PoC strategies appropriate to each stage, with outcome variables of PA, muscle strength and balance, with the aim of reducing risk of osteoporosis. Given the high rates of osteoporosis and also low exercise rates of

<table>
<thead>
<tr>
<th>Components of processes used</th>
<th>Learning objectives</th>
<th>SoC</th>
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<tbody>
<tr>
<td>Experiential/cognitive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consciousness raising</td>
<td>To find out more about PA</td>
<td>*</td>
</tr>
<tr>
<td>Environmental re-evaluation</td>
<td>To identify the impacts of inactivity on physical and social environments</td>
<td>*</td>
</tr>
<tr>
<td>Dramatic relief</td>
<td>To demonstrate the affective aspects for inactive or persons affected by osteoporosis</td>
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<tr>
<td>Self-re-evaluation</td>
<td>To consider reappraisal of values by the individual with respect to inactivity</td>
<td>*</td>
</tr>
<tr>
<td>Social-liberation</td>
<td>To accept and realize that society is changing to support and encouraging active lifestyles</td>
<td>*</td>
</tr>
<tr>
<td>Environmental/behavioral</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Counter conditioning</td>
<td>To suggest some substitutions of PA for sedentary behavior</td>
<td>*</td>
</tr>
<tr>
<td>Helping relationships</td>
<td>To seek and use social and family supports to help initiate and maintain PA</td>
<td>*</td>
</tr>
<tr>
<td>Reinforcement management</td>
<td>To indicate intrinsic and extrinsic rewards to encourage or maintain PA</td>
<td>*</td>
</tr>
<tr>
<td>Self-liberation</td>
<td>To making a firm commitment to increase PA, to believe in one’s ability to change</td>
<td>*</td>
</tr>
<tr>
<td>Stimulus control</td>
<td>To identify and avoid stimuli and other causes that provoke inactivity</td>
<td>*</td>
</tr>
</tbody>
</table>

PC, pre-contemplation; C, contemplation; P, preparation; A, action; M, maintenance.
*Component present.
women in Iran, the purpose of this study was to design and evaluate a 12-week exercise education intervention program based on TTM to improve adherence with strength training and balance retraining recommendations suitable for the cultural context of older Iranian women. This is the first randomized controlled trial to include and evaluate the TTM components of training in a study of exercise promotion to prevent osteoporosis.

**Methods**

**Design and participants**

The study was a randomized controlled trial with two conditions, and pre–post intervention measurements of stage of change, PA level, muscle strength and balance.

This paper reports findings from a larger study, in which the required sample size to achieve 80% power at 5% level of significance on the main variable of interest (dietary calcium) between the training and control groups was calculated to be 52 [5, 16]. To allow for attrition and non-suitability of participants, 200 women were invited to take part. This part of the study found a mean (SD) difference of 7.6 (3.4) in static balance (centimeter) between the training and control groups in change from pre-to post-training, and a retrospective sample size calculation achieved power in excess of 95%. Similar power was achieved when considering the difference in changes in muscle strength (kilogram) between the two groups (mean = 2.4, SD = 1.7).

There are 39 urban District Health Centers located in four homogenous socio-economic areas in Shiraz, Iran. In the first stage of randomization, we randomly selected one area consisting of nine centers. Then, two centers were randomly selected and assigned to a training center and control center. In each center, 100 women who might be expected to meet our study inclusion criteria (age 40–65 years old, education of at least fifth grade) were randomly selected to take part. Their contact details were obtained from the records in the centers. Twenty-eight women in the training center and 37 women in the control center refused for various reasons. Twenty-two women in the training group and 30 in the control group who refused to participate in the research refused because they would not permit home visits. Four women in the control group were excluded as they were engaged in osteoporosis preventive behaviors under the advice of their physicians. The remaining nine (six in the training group and three in the control group) refused because they stated that they were too busy with their household responsibilities to participate in our program. In attempting to control for factors that differed between respondents and non-respondents, we acknowledge that we were unable to assess and subsequently control for osteoporosis preventive behaviors and other variables among those who did not respond.

The remaining 72 women in the training center and 63 women in the control center were screened by the physicians for exclusion criteria: cardiovascular, neurological, systemic illness and osteoporotic fractures. We excluded women with pregnancy, a previous diagnosis of osteoporosis, or severe musculoskeletal disability, which would limit exercise. After initial screening, 61 women in the training center and 55 women in the control group were available for Time 1 assessment and all women also were available for Time 2 and 3 assessments without any drop-out (Fig. 1). The centers were far enough from each other to minimize the likelihood of contact between women (contamination). The assessments were performed by researchers who were blinded to the group types of participants. At the end of the education program, all women agreed not to engage in any strengthening or aerobic exercise in addition to the experimental protocol. The women in the control group were placed on a waiting list for the intervention. The Tarbiat Modares University ethics board approved the study and all participants provided written informed consent.

**Measures**

*Stages of exercise change*

The Stages of Exercise Change Questionnaire (SECQ) was adapted from Marcus et al. [17]. The
Stages and their basic definition, in terms of exercise behavior were pre-contemplation (not participating in exercise and not thinking about starting in the next 6 months), contemplation (not participating in exercise but thinking about starting within 6 months), preparation (doing some exercise but below a criterion level), action (started participating in exercise above a criterion level in the last 6 months) and maintenance (participating above a criterion level for >6 months). The criterion level was defined as exercising three times per week for ≥20 min at a moderate intensity or higher [18]. Five statements were presented (one based on each stage of change) and the participant was asked to select the statement that best described her current level of exercise. The Kappa index of reliability for the SECQ, taken over a 2-week period was 0.78 (n = 20) [17]. Concurrent validity for the SECQ was evidenced by its significant association with the 7-day PA recall questionnaire [19, 20].

**Physical activity**

PA was assessed by an adapted short version (continuous score) of the International Physical Activity Questionnaire (IPAQ) [21] which provided information on the time spent on walking (as exercise), vigorous and moderate-intensity activity.

Fig. 1. Protocol of the intervention study. Week 2 assessment just for stage of change.
IPAQ was developed by an international consensus group, which met in Geneva 1998, as a self-reported measure of PA suitable for population surveillance of adults 15–69 years. It has been used also as an evaluation tool in some intervention studies. Validity and reliability of the instrument have been reported [22]. Given the focus of the research on exercise behavior change, data are presented as mean minutes (not mean Met-minutes).

**Muscle strength**

Muscle strength was measured as the force generated during a maximum voluntary contraction. The one-repetition maximum (1RM) test is typically used to measure strength in the research setting. One advantage is that this test is more specific to the type of training participants would be most likely to perform to enhance strength levels [23].

The 1RM was used as the measure of muscle strength of the knee extensor. A 1RM signifies the maximum resistance a person can move in one repetition of an exercise. To estimate a person’s 1RM, we determined an nRM ($n \leq 10$). We used a regression equation attributed to Brzycki [24].

$$1RM = \frac{\text{weight lifted during nRM}}{1.0278 - 0.0278(n)}.$$  

The formula permits assessment of muscular strength in a safe, efficient manner without requiring participants to attempt maximum lifts.

Ankle cuff weights were used to provide resistance during the test. They were available in a range of styles and weights. They could be added to or replaced with heavier weights when the person could achieve >10 repetitions.

**Static balance**

Functional reach is the maximal distance an individual can lean forward with his/her arm flexed to 90° while maintaining a fixed base of support in the standing position. This was assessed to determine static balance as it is predictive of falls and functional status, it is related to the range of motion of axial spinal rotation, and it is sensitive to change with exercise [25, 26].

**Dynamic balance**

Dynamic balance is the ability to anticipate changes and coordinate muscle activity to perturbation of stability [23]. Dynamic balance was evaluated by performing the star-excursion balance tests (SEBTs). This is a functional test that incorporates a single-leg stance on one leg with maximum reach of the opposite leg. The reliability of the SEBTs has been investigated in two previous studies [27, 28]. Due to space and cost requirements associated with instrumental devices, they were neither affordable nor practicable for the clinical setting. Thus, a simple, reliable and valid method of lower limb functional performance was needed [29]. The star-excursion test offers a simple, reliable, low cost alternative to more sophisticated instrumented methods that are currently available [28].

**Procedure**

Two health professionals who were speakers of the language of Iran and graduated at British Universities translated the questionnaires into Persian. The questionnaires were backward translated into English by a native English speaker living in Iran.

The PA questionnaire was completed before and after the intervention, and the SoC of exercise was assessed at baseline, and at weeks 2 and 12 of the program for all participants. Muscle strength, dynamic and static balance tests were performed before starting the exercise program with the final testing after the intervention, and each was performed by one of the specially trained physical therapists on all assessments. Prior to testing, all procedures were demonstrated to participants. Each woman was tested by the same tester on all visits.

**Intervention**

**Education program**

The education program had both a common part and a stage-specific part. The common instructional strategies of the program included the following:

(i) ‘Gain attention’ to the program through raising consciousness about osteoporosis risks, severity and consequences of a sedentary lifestyle.
(ii) Enhance ‘relevancy’ and perceived susceptibility using peer-case presentation.
(iii) Set progressive ‘small objectives’ tailored to each participant.
(iv) Make instructions ‘easy’ to understand and to do.
(v) ‘Enhance self-efficacy’ for desired behaviors.
(vi) ‘Encourage’ the participants to continue the program by providing appropriate feedback and verbal incentives.
(vii) Develop ‘social support’ by family interviews.

After collecting baseline data, the training group was divided into seven subgroups according to their SoC; four subgroups of pre-contemplation and contemplation, two subgroups of preparation and one for action. Each subgroup included a maximum of nine women. All subgroups were asked to participate in two preparatory instructional sessions (i.e. the common part of the training intervention). The instructions were tailored to the subgroups, and the sessions were carried out in two subsequent weeks. The lectures were presented by using videos, slides and posters. Participative methods included group discussion and self-estimation of osteoporosis risk to provide an active learning process.

The education materials of the common part of the training intervention aimed to increase the participants’ knowledge of osteoporosis, the risk factors and effects and preventive behaviors with a focus on the benefits of exercise and muscle strength training. The sessions aimed to increase awareness of personal susceptibility to osteoporosis and the threats of fractures. The importance of performing regular PA with the aim of prevention of osteoporosis and falls was explained during these sessions.

Instructions were tailored to participants’ stage of change. The PoC has been applied in PA intervention previously [14], where it was found that experiential processes are used more in the early SoC, while use of behavioral processes tends to peak in the action stages [30, 31]. So, for the pre-action stages (pre-contemplation, contemplation and preparation), the education was focused on increasing emotional readiness to change and start exercise. In the action stages (action and maintenance), the intervention concentrated on the skills needed to implement and maintain appropriate daily exercise. Every 2 weeks, the participants’ stages in the trial group were determined and each woman received reminder cards and a pamphlet based on her most recent stage. She was asked to display the cards in a suitable place at home. Table I summarizes the educational objectives and integration of the stages and processes used in reminder cards and pamphlets [31].

The exercise education program began with a home-visit session for each participant in preparation and action stages and for others, as soon as they progressed to these stages. The main objective of this phase was improvement of muscle strength and balance. To start the program, we showed the participants the exercise booklet that explained the exercise instructions during the session as each individual exercise was prescribed. The instructor took the person through the exercise ensuring she was safe and confident with each one and could understand the illustrations and instructions. All women had the instructor’s contact telephone number and were asked to report any changes in physical symptoms or exacerbations of existing medical conditions such as arthritic pain, where women were advised to stop exercising and to contact the team’s physician. We involved family members in recruitment and in carrying out the program.

Exercise program

The exercise program was progressive, individually tailored and included a walking program as a weight-bearing exercise.

We used elastic bands that were inexpensive, transportable and took up minimal space [32]. The muscles exercised were the hip extensors, hip flexors, hip abductors, hip adductors and knee extensors, because they are important for transferring and fall prevention. Each participant received an elastic band with the same thickness and varying wideness specified according to her own 1RM at the baseline measurement, as the widths of 3, 5 and
7 cm were used, for 1RMs of <5, 5–7 and >7 kg, respectively.

Prior to the strengthening exercises with the elastic band, participants did a 5-min stretch warm-up, and a similar cool down was performed after the exercise session. Strengthening exercise included five exercises with elastic bands that were performed progressively (see Table II).

Each repetition lasted 5–6 s, with a 3-s rest between repetitions, 60 s of rest between sets and 2 min rest between exercises. Right and left legs were trained at the same time and each session lasted 30–45 min and was separated by 1 day of rest. After strengthening exercises, the participants performed one of the three balance training exercises (knee bends and forward lean), with progression from Level 1 (the first or easiest) to Level 4 (the most difficult), as shown in Table II. The instructor observed the participant during the holding version of each balance exercise before prescribing the exercise without holding support. The prescription for walking was at least 30 min day⁻¹ that was broken up into two or three minimum 10-min sessions.

**Statistical analyses**

Data analyses were completed using the statistical software program SPSS version 12. Two-tailed tests were performed and a 5% level of significance was set.

Baseline demographic data are described using means and standard deviations (SDs). Comparisons of study variable means at baseline between the training and control groups were performed using the two-tailed, independent Student’s *t*-test for all but PA measures. PA was combined (walking, moderate and vigorous exercise) to produce an overall time in minutes spent exercising. PA measures were compared between training and control groups using the Mann–Whitney (M-W) test, as these data were not normally distributed. PA stages of readiness to change PA behavior were merged into two categories: pre-action (pre-contemplation, contemplation and preparation) and action (action and maintenance). Chi-square tests were used to compare these categories between the two groups at pre- and post-training. Progression through the time points for the two groups was compared using the Friedman test. Univariate analysis of covariance was performed on the change from pre- to post-training values of appropriate outcome variables, with the pre-training values used as covariate. Change in PA data between groups was compared using M-W test.

### Results

#### Program adherence and compliance

The prescribed moderate-intensity exercise criterion of at least 20 min session⁻¹ for 3 days week⁻¹ over the 10 weeks of exercise program was attained by 47.5% of the participants in the training program, compared with 20.0% of the control group (exact $\chi^2 = 9.71$, $P = 0.003$).

#### Pre-training data

Baseline demographic characteristics of the population are summarized in Table III. There were no significant baseline differences in age, body mass index and education level, between the training and control groups. At baseline, there were similar proportions of participants in each of the five stages (see Table IV) and chi-square analysis indicated no significant difference between pre-action and action categories at baseline. Thirty-two percent

**Table II. Levels and number of repetitions for the strengthening and balancing exercise**

<table>
<thead>
<tr>
<th>Weeks</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1–2</td>
<td>3–4</td>
<td>5–6</td>
<td>7–10</td>
</tr>
<tr>
<td>Strengthening exercise</td>
<td>1 set × 5 repetition, hold support</td>
<td>1 set × 8 repetition, no support</td>
<td>2 set × 5 repetition, no support</td>
<td>2 set × 8–10 repetition, no support</td>
</tr>
<tr>
<td>Balance exercise</td>
<td>10 s⁻¹, 1 repetition</td>
<td>10 s⁻¹, 1 repetition</td>
<td>10 s⁻¹, 2 repetition, no support</td>
<td>10 s⁻¹, 3 repetition, no support</td>
</tr>
</tbody>
</table>
in the intervention and 38% of the control groups reported spending any time on PA at baseline. Chi-square analysis indicated no significant difference in performing exercise, or not, between the two groups.

The t-tests revealed no baseline differences between groups in static balance and other directions of dynamic balance, but 1RM ($P < 0.001$) and the right-posterior direction of dynamic balance were significantly higher in the control group than training group (see Table V).

**Post-training data**

**Stage of change**

Progression in SoC was used as one of the criteria of intervention success. A highly significant difference at the end of the training program ($\chi^2 = 45.8, P < 0.001$) was found between the training and control groups. Figure 2 illustrates these differences.

Individuals in the training group had a positive, significant progression through the pro-

<table>
<thead>
<tr>
<th>Table III. Baseline characteristics of participants</th>
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<tbody>
<tr>
<td>Characteristics</td>
</tr>
<tr>
<td>------------------</td>
</tr>
<tr>
<td>Age (years)</td>
</tr>
<tr>
<td>Education (years)</td>
</tr>
<tr>
<td>Height (cm)</td>
</tr>
<tr>
<td>Weight (kg)</td>
</tr>
<tr>
<td>Body mass index (kg m$^{-2}$)</td>
</tr>
</tbody>
</table>

**Other outcome variables**

Figure 3 illustrates the overall time in minutes spent exercising pre- and post-training. The outliers (small circles and asterisks) show that a few members in both groups were spending more time exercising than the majority, although the training group increased the time spent exercising overall (M-W $Z = -4.13, P < 0.001$). Results of univariate analyses of variance on the changes from pre- to post-training, with baseline values and the two variables identified as significantly different at baseline used as covariates, indicated very highly statistically significant differences (all $P < 0.001$) between the training group and the control group for all outcome variables (see Table V). It was noted that the assumption of homogeneity of variance was not met for these tests, possibly due to the very small changes in measures within the control group. Equivalent non-parametric analyses
A TTM-based home exercise to prevent osteoporosis in Iranian women: a randomized controlled trial

Discussion

The study examined the effectiveness of a TTM-based intervention designed to promote PA, and reported the effect of a home-based, tailored progressive and strength training exercise program to improve muscle strength and balance.

In this study, we achieved 100% cooperation (in both groups) without any payment. In addition to the general instructional strategies of the program which were well-received, this high retention rate may have been influenced by the program being free of charge, and novel to all women participating in the health program, along with the short period of follow-up and the frequent home visits during the program and data collection stages.

Education and stage of change

Based on the results of the staging algorithm, at the baseline, there were very large percentages of participants (intervention 88.5%, control 94.6%) in the pre-action stages. The intervention group showed a progression in stage compared with the control group. The increased number of participants in the preparation and action stages at the endpoint of the common education program part of the experimental training program (2 weeks) may be attributed to the educational strategies used.

The stage of change construct is based on the premise that education can promote an individual’s progression through stages [33]. According to the PoC, providing information to individuals in pre-contemplation is an effective strategy for helping them move into contemplation. Other intervention studies have shown a positive relationship between knowledge and stages [33–35]. Knowledge

<table>
<thead>
<tr>
<th>Training group (n = 61)</th>
<th>Pre-</th>
<th>Post-</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Median (range)</td>
</tr>
<tr>
<td>PA</td>
<td>54.1 (131.5)</td>
<td>0 (0–650)</td>
</tr>
<tr>
<td>Muscle strength (1RM)</td>
<td>5.6 (1.5)</td>
<td>5.3 (1–9.7)</td>
</tr>
<tr>
<td>Static balance</td>
<td>11.1 (3.6)</td>
<td>11 (5–19)</td>
</tr>
<tr>
<td>Dynamic balance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left anterior</td>
<td>61.4 (6.3)</td>
<td>61 (40–73)</td>
</tr>
<tr>
<td>Right anterior</td>
<td>57.6 (7.0)</td>
<td>58 (35–71)</td>
</tr>
<tr>
<td>Left posterior</td>
<td>47.5 (9.7)</td>
<td>48 (24–71)</td>
</tr>
<tr>
<td>Right posterior</td>
<td>42.1 (7.8)</td>
<td>42 (18–64)</td>
</tr>
<tr>
<td>Control group (n = 55)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PA</td>
<td>73.9 (131.2)</td>
<td>0 (0–540)</td>
</tr>
<tr>
<td>Muscle strength (1RM)</td>
<td>7.0 (1.6)</td>
<td>6.9 (3.3–10.1)</td>
</tr>
<tr>
<td>Static balance</td>
<td>11.7 (2.67)</td>
<td>12 (5–18)</td>
</tr>
<tr>
<td>Dynamic balance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left anterior</td>
<td>62.1 (9.14)</td>
<td>63 (27–80)</td>
</tr>
<tr>
<td>Right anterior</td>
<td>58.1 (9.4)</td>
<td>59 (24–77)</td>
</tr>
<tr>
<td>Left posterior</td>
<td>50.9 (10.6)</td>
<td>52 (26–70)</td>
</tr>
<tr>
<td>Right posterior</td>
<td>46.9 (10.9)</td>
<td>49 (20–70)</td>
</tr>
</tbody>
</table>

*M-W test* revealed the same, very clear, significant results.

Post-test average significantly different from pre-test average, \( P < 0.001 \), using M-W \( U \)-test on change scores from pre- to post-training. \( ^b \)Post-test average significantly different from pre-test average, \( P \leq 0.001 \), using univariate analysis of variance on change scores from pre- to post-training with baseline data as covariate. \( ^c \)Training group significantly different from control group at baseline, \( P \leq 0.01 \), using independent \( t \)-tests.

Table V. Summary statistics on overall PA, muscle strength and dynamic balance for both groups before and after training
programs such as a lecture on the topic of osteoporosis have helped people in contemplation and preparation to change their attitudes or to prompt them to move into action [36]. At the third follow-up point (12 weeks), the high number of participants in the action stage may be attributed to the high levels of adherence to the exercise prescription. Also, it could be related to their former progression in stages after the common part of intervention. DiClemente and colleagues found that helping people progress through just one stage can double their chances of successful behavioral changes in the near future [14].

At the baseline, both training and control groups demonstrated low levels of PA; however, after 12 weeks of the intervention training, group performance significantly improved. Although it cannot be ruled out that self-assessment measures of exercise are subject to reporting biases [37, 38], in this study objective measures were also used to provide reliability checks on the impact of the intervention. Similar to other research findings [19, 20, 39, 40], in the present study, stage of change as a self-reported instrument has been shown to correspond accurately with more objective measures of PA, e.g. IPAQ, muscle strength, dynamic and static balance.
Exercise prescription and PA

A moderate home-based exercise program was chosen for the present study as the moderate exercise prescription could be easily followed by a healthy individual over a lifetime and it is frequently recommended by health professionals [41–43]. Also, the effectiveness and efficiency of home exercise programs have been reported previously [44–47].

For some women, exercising at home is the most realistic and desirable option. Individuals can exercise whenever they desire, without the constraint of a class schedule, and they can adapt their program as necessary to match their goals [32]. This could be more important in a developing country due to the high costs of any group exercise program. The inclusion of two group-education sessions at the start of the program may have increased social support among participants for health behavior change.

Another aspect of our prescription was the use of elastic bands in strength training exercise. Elastic bands were readily available and inexpensive, and this equipment was accepted by participants very well. Although more improvement in muscle strength and physical function by using some expensive equipment (machines) and free weights (dumb-bells and ankle weights) has been reported than elastic bands [32], the current research indicates that strength training using elastic bands can improve muscle strength by an average of 58%, dynamic balance 8.53% and static balance 66.18%. These improvements can be clinically significant. Tinetti et al. [48] investigated the effectiveness of a multi-factorial intervention program on a number of risk factors for falls and concluded that a change in balance score of 1, where possible scores ranged from 0 to 12, was associated with an 11% reduction in fall rates [49]. Winters and Snow [50] in a study involving pre-menopausal women found that impact plus lower limb resistance exercise significantly increased knee extensor and hip abductor strength by 17 and 27%, respectively. They also found that dynamic postural stability was improved by 24%, and that lead to significant increases in trochantric and femoral neck Bone Mineral Density of 2.5 and 1.5%, respectively.

Although several trials have demonstrated the effectiveness of a home-based strength and balance program, they showed various results depending upon study group chosen, exercise intervention and measurements instruments. In a study by Jette et al. [51], disabled men and women aged 60 years old or more were trained in a home-based intervention using elastic bands of varying thickness. After the intervention, strength had improved 6–12% in the lower limbs, and tandem gate improved 20% in the exercise group. Campbell et al. [44, 45], in an individualized program of lower limb strength and balance exercises, showed a significant reduction in the rate of falls per annum among women aged 80 years and older, compared with a control group. Robertson et al. [46, 47], in a home-based strength and balance training program reported that after the intervention the number of falls was reduced by 30%. These studies illustrate that a home-based approach offers a feasible method for implementing strength and balance training programs in older adults. Gardner et al. [52] found similar results to this study in New Zealand for the combined effects of walking plus resistance training in increasing both lower extremity strength and balance. Walking and other activities should be part of comprehensive strength and balance training programs for older adults in community health promotion programs. These results suggest that an exercise program that incorporates the use of elastic bands can produce improved muscle strength, dynamic and static balance in middle-aged and older women.

Therefore, it is suggested that this type of training be incorporated into the exercise routines of apparently healthy adults and used as part of specific falls and osteoporosis prevention programs.

Although the present study reported meaningful findings, there are limitations that need to be taken into consideration when interpreting the results and planning future research. Perhaps the biggest limitation is that there is no post-intervention follow-up due to the time restriction for performing the study, so it is not possible to assess the maintenance or generalization of effects into sustained
healthy exercise beyond the exercises prescribed in the program.

To summarize, a combination of three factors, (i) giving the importance of exercise in terms of disease prevention such as osteoporosis, (ii) tailoring the messages and exercise prescription to the stages and PoC and (iii) prescribing a home-based, inexpensive, individualized and progressive strength training program, is feasible and effective method to encourage sedentary middle-aged and older women to do exercise.

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**Conflict of interest statement**

None declared.

**References**

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