Original Article

# Mini-Trampoline Jumping as an Exercise Intervention in Postmenopausal Women to Improve Women Specific Health Risk Factors

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## Abstract

**Background:** Women tend to outlive men and are at higher risks of functional disability compared to men. Specifically, women are more likely to develop conditions like osteoporosis and stress urinary incontinence which can further increase the risk of functional disability. Regular physical activity and/or exercise programs can minimize the physiological decline that occurs during aging and can improve overall physical fitness, bone health, and pelvic floor muscle function; however, exercise programs tend to focus on only one parameter. Mini-trampoline jumping is a highly beneficial low-impact aerobic exercise capable of improving aerobic fitness, balance, muscle strength, and potentially bone health as well as pelvic floor muscle functioning. The aim of the proposed research project is to examine the benefits of a 3-month mini-trampoline exercise intervention on physical fitness, bone health, and pelvic floor muscle functioning in postmenopausal women. **Methods:** Fifty postmenopausal healthy women aged 50–69 years will be recruited. Assessments on physical fitness (aerobic fitness, walking speed, balance, lower extremity strength, flexibility), bone health, and pelvic floor muscle functioning will occur within 1 week before and after the exercise intervention, including a 3-month follow-up assessment. The exercise intervention will last 12 weeks, with three sessions of 40 min each per week. **Conclusions:** The proposed research has the potential to improve functional ability and women-specific risk factors in older women with an innovative and fun exercise program.

**Keywords:** *Osteoporosis, pelvic floor, physical fitness, postmenopause*

## Introduction

Physical functional ability is key to elderly individuals maintaining an independent lifestyle.[1] Any deficits in muscle strength, mass, power, and endurance can limit mobility and activity, especially for women.[2] Older women are at higher risk of functional disability compared to older men, as older women are also more likely to develop conditions like osteoporosis and urinary incontinence, which can both decrease overall activities of daily living.[3,4] Menopause is known to have the single greatest effect on overall bone mass loss and osteoporosis,[4] which affects four times as many women as men. Importantly, decreased bone mass significantly increases the risk of fractures, disability, and chronic pain.[3]

Stress urinary incontinence is considered to be the most prevalent form of urinary incontinence[5] and commonly occurs during some form of physical exertion or during sneezing and coughing.[6] Urinary incontinence can create serious medical conditions (e.g., urinary tract infections) but also to social problems (e.g., embarrassment), reducing social interactions and physical activity.[7] Women are specifically susceptible to stress urinary incontinence because the pelvic floor musculature in women weakens with older age due to sarcopenia, childbirth trauma, and/or menopause.[6]

Regular physical activity can minimize the physiological decline that occurs during aging and improve overall physical fitness, bone health, and pelvic floor muscle function; however, exercise programs tend to focus on only one parameter.[6,7] Several studies have shown that sedentary adults are at a larger risk of functional decline compared to adults who exercise regularly and exercise is highly recommended to reduce these risks.[1] Although studies have shown significant improvements for overall physical performance when participating in an exercise intervention, no study

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to date also included other functional ability measures that specifically focus on health risks associated with postmenopausal women.

The ability to remain functionally independent is reliant on several physical abilities and, thus, it is important that exercise interventions do not rely on a single measure to improve general function. Furthermore, research on exercise programs that could improve pelvic floor muscle functioning is sparse, with no clear exercise intervention identified. Mini-trampoline jumping, also known as rebounding, is a highly beneficial low-impact aerobic exercise capable of improving aerobic fitness, balance, muscle strength, and postural control in young as well as older adults.[8-10] Mini-trampoline exercises incorporate a multicomponent approach, which affects many physical factors including strength, body stability, muscle coordinative responses, joint movement amplitudes, and spatial integration.[8] Yet no research has examined the effects of a mini-trampoline exercise intervention on older women's health.

Therefore, the aims of this intervention study are to understand the benefits of a 3-month mini-trampoline exercise intervention on i) physical fitness, ii) bone health, and iii) pelvic floor muscle functioning in postmenopausal women.

## Methods

### Study design

This is a randomized exercise intervention study with pre-, post-, and follow-up measures. Figure 1 represents a schematic timeline of the study design following the initial recruitment. The study has gained ethical approval from the Massey University Ethics Committee (Southern A 18/52).

### Participants

Fifty postmenopausal healthy women aged 50–69 years will be recruited. It is believed that this aged cohort would benefit the most from the mini-trampoline exercise intervention: physical function has started to decline but women would still be able to safely perform the exercises.[11] Eligible participants will undergo prescreening for inclusion and exclusion criteria [Table 1]. A health history questionnaire and the Physical Activity Readiness Questionnaire (PAR-Q) will be used to determine eligibility and readiness to participate in exercise. Participants will be recruited from the Wellington region via flyers and advertisements. Regional companies and sports clubs will be contacted directly via e-mail and phone to increase engagement with external stakeholders.

Ten of the recruited women will be assigned to a control group while 40 will be assigned to an exercise group. The sample size was calculated based on a study examining the effects of a mini-trampoline exercise intervention on balance and strength improvements in older adults.[8] Based on the means and standard deviations provided in that study, the sample size required to achieve a power of 0.8 and 95% CI is $n$ = 33 for changes in balance and $n$ = 36 for changes in lower extremity muscle strength. Accounting for 10% attrition, a total of 40 participants will be necessary to see appropriate changes in physical function after the 3-months exercise intervention. Very little change is expected in the control group; thus, the relatively small amount of variability reduces the sample size required for the control group.

### Assessments

The primary outcome measures for this study are indicators of physical fitness, sub-categorized as aerobic fitness, gait, balance, lower extremity muscular strength, lower extremity flexibility. Secondary outcome measures include bone health of the calcaneus and pelvic floor muscle functioning. All parameters will be measured within one week prior to commencing the exercise intervention, within 1 week following the exercise intervention and 3 months following the exercise intervention.

### Primary outcome measures

The primary outcome measure for this intervention is functional fitness, which comprises aerobic fitness, walking ability, balance, strength, and flexibility. As all of these components are known to decline in function with increasing age, they are directly targeted in the exercise intervention.[11] A mini-trampoline exercise program has the potential to improve overall functional fitness with its multi-component approach.[8]

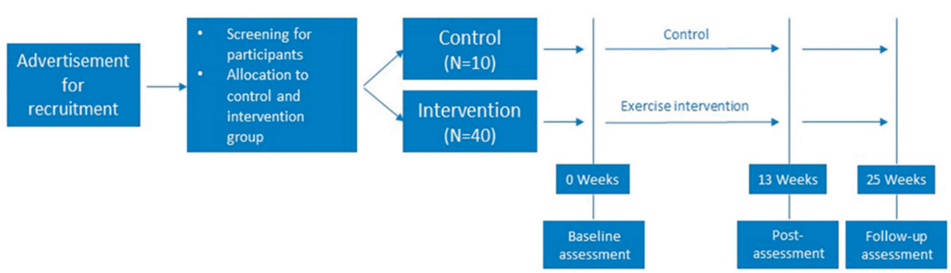


**Figure 1: Schematic timeline of the proposed study**

**Table 1: Inclusion and exclusion criteria**

| | |
|---|---|
| Inclusion criteria | Female aged 50-69 years |
| | Postmenopausal for at least 12 months |
| | Able to walk independently without any aid |
| | Agree not to take bone altering medication and supplements |
| | Able to travel independently to research and exercise sites |
| Exclusion criteria | Neuromuscular conditions such as multiple sclerosis and Parkinson's |
| | Lower extremity bone fractures or knee and hip replacements within the last 12 months |
| | Uncontrolled hypertension |
| | Uncontrolled cardiovascular diseases |
| | Severe lower extremities arthritis |
| | Severe lower orthopedic diseases |

### *Aerobic fitness*

Aerobic fitness will be assessed with the 6-min walk test. The test will be performed indoors on a flat surface in a rectangular course (5 m in length and 1 m in width). Participants will walk as fast as they comfortably can for 6 min and the total distance covered at the end of the 6 min will be measured. The 6-min walk test has previously demonstrated to produce good test-retest reliability in measuring aerobic fitness in older adults.[12]

### *Walking speed*

Walking speed and lower extremity strength will be assessed during a 10-m walking test. Participants will walk a total of 20 m (with 5 m provided at the beginning and the end for acceleration and deceleration, respectively) at their comfortable walking speed on a flat and straight surface. Timing gates at the start and end of the 10 m will record the time. Participants will perform three trials with 1-min rest breaks between each trial. This test has previously been validated to measure lower leg strength and walking speed for older adults.[13]

### *Balance*

#### Dynamic balance

The dynamic balance will be assessed with participants standing on a force platform (AMTI, Watertown, MA, USA) with feet shoulder-width apart and arms stabilized at the hip. Participants will be asked to shift their weight anteriorly and posteriorly, and then laterally to the right and left sides as far as possible while retaining their balance. The tasks will be performed repeatedly over a period of 20 s, whereby participants shift their weight in all directions during that time period. The total path length, path length along the medial-lateral as well as anterior-posterior axis, maximal range of sway in the anterior-posterior as well as medial-lateral direction, and velocity along the medial-lateral as well as anterior-posterior axis will be assessed. The center of pressure measurements has been deemed valid and reliable in testing balance in older adults.[14]

#### Static balance

The static balance will be measured during a two-legged stance with participants standing on the force platform shoulder-width apart with eyes closed for 30 s. Participants will also perform a one-legged stance with eyes open for 30 s. Three trials for each condition will be performed and the center of pressure will be recorded. To understand the pattern of movement, movement range and length of path will be analyzed and a multifractal analysis will be performed.[15]

### *Lower extremity strength*

Lower extremity muscle strength will be further assessed with the chair based sit-to-stand-test. Participants will be seated on a standardized 40 cm high chair and stand up from the seated position for 10 times as fast as possible. The time it takes to sit and stand 10 times will be recorded. The chair-to-stand test provided good test-retest reliability and good criterion-related validity in measuring lower limb strength in older adults.[16]

### *Flexibility*

Hamstring flexibility will be assessed with the sit-and-reach test. Participants will place the soles of their feet against the sit-and-reach box. Participants will slowly reach forward with both hands as far as possible to a position that can be maintained for 2 s. Hands have to be in a parallel position to each other and fingertips should be in contact with the measuring tape of the sit-and-reach box. The score that is the most distant point reached with fingertips and held for 2 s will be recorded in cm. Three trials will be performed, while the best out of three trials will be recorded. The sit-and-reach test has been validated to be a good predictor of hamstring flexibility.[17]

## Secondary outcome measures

Secondary outcome measures include bone health and pelvic floor muscle functioning. Both outcome measures are specific health risks for aging women, which are known to decline in functioning in postmenopausal women.[4,5] Based on previous research, a mini-trampoline exercise intervention might have the potential to improve bone health in the calcaneus as well as pelvic floor muscle functioning.[8-10] Bone health in the calcaneus might be improved through the mechanical loads that will be applied through contact with the base of the mini-trampoline. Any tension, compression and torsion at the tendon and bone complex create electrical signals that stimulate bone metabolism and possibly inhibit bone reabsorption.[18] The pelvic floor muscles are believed to be highly active during trampoline exercises and thus might be strengthened following an exercise program.

### *Bone health*

The bone health of the calcaneus will be assessed via a qualitative ultrasound measure. The ultrasound parameters taken from the calcaneus have shown high correlations with bone mineral density in the hips of older women. A qualitative ultrasound measure is therefore recommended as an inexpensive tool to screen for bone health in older women.[19] Participants will be seated comfortably on a chair while ultrasound gel is applied to the pads of the ultrasound machine. The thoroughly cleaned right foot of participants will be placed on the ultrasound machine with the lining of the machine placed between the hallux and second phalanx. The foot will be kept stable with a brace during measurements.

### *Urinary incontinence and pelvic floor muscle functioning*

The degree of urinary incontinence will be assessed with the female urinary incontinence diagnosis questionnaire. This short 6-item urinary incontinence symptom questionnaire has previously been validated to be used as an outcome measure in clinical trials.[20] The functioning of the pelvic floor musculature will be examined via surface electromyography (EMG) (Noraxon, Arizona, USA). During the initial meeting prior to the first testing session, participants will be taught the structure and anatomy of the pelvic floor muscle to help create awareness of this muscle group, its location and function. Participants will be instructed to try and stop voiding during micturition on only a couple of occasions to feel the pelvic floor muscles. This protocol has been used in previous studies in order for participants to contract the correct muscle group during testing.[21] Participants will void their bladder immediately prior to testing in order to standardize bladder volume. Participants are provided with verbal instructions to insert a vaginal probe as they would do when inserting a tampon; the two conducting plates must be placed laterally (with one plate facing their right side of the body and the other plate facing the left side of the body). Participants will be instructed to perform maximum voluntary contractions of the pelvic floor muscle while in a standing positing and hold this contraction for 10 s. Following the 1-min rest period, participants will then perform three maximal effort coughs. Testing will be repeated three times with 1-min rest breaks in between each trial. This protocol aligns with previously validated and reliable protocols.[22,23]

## Exercise intervention

Forty of the 50 recruited participants will be assigned to the intervention group and 10 participants will be assigned to the control group. The control group will only attend the pre-, post-, and follow-up assessments and will be instructed to continue with their daily routines for the 12 week period between assessments. Participants in the intervention group will partake in a mini-trampoline exercise program for 12 weeks, with 40-min sessions occurring three times a week. Mini-trampoline exercises will concentrate on movements to improve aerobic fitness, flexibility, lower extremity strength and balance, as well as pelvic floor muscle activation. Exercises were chosen for their ability to scaffold in progression throughout the program. Specifically, exercises will start with simple and basic movements and progress to more challenging and interactive tasks throughout the 12 weeks.

Exercises will be performed on a mini-trampoline with handlebars. During the course of the exercise program, participants will be encouraged to perform exercises without holding onto the handlebar; however, this is dependent on individual ability, progress and confidence. The researcher will conduct each training session in a small group with a maximum of six participants. Exercise sessions will be performed at Massey University in Wellington or at community locations to minimize the burden on participants. In addition to the primary researcher, each exercise session will also be attended by a research assistant who will ensure that participants are performing exercises safely and correctly. Each participant will be provided with a heart rate monitor during the exercise sessions. For the exercise to be effective the heart rate should continuously be between 40 and 75% of the age-predicted maximum heart rate (HRmax = $208 - 0.7 \times$ age). If the heart rate reaches near-maximal values (80% HRmax), participants can reduce the intensity or take short rest breaks.

## Adherence

A potential challenge to this intervention study could be adherence to the exercise program. The most commonly reported motivators to exercise were those that are linked to health and fitness benefits in older adults.[24] The potential health benefits of this intervention study are vast which should enhance adherence to this exercise program. Furthermore, exercise sessions of our study will be performed in small groups of six people, allowing for social interactions. It has been well documented that individuals' compliance to exercise program are greatly increased if social interactions and social integration are well maintained during the exercise program.[25] The intended participants for this intervention study are aged 50–69 years, therefore it can be expected that the majority of participants are still in the workforce. For individuals who work full-time, time might be a compliance issue. However, this study will offer the opportunity for testing and exercise sessions to occur within the premises of participating companies if a suitable room can be provided, allowing participants to partake in the intervention study without having to travel. Furthermore, exercise sessions are only 40 min long and could, therefore, occur during lunchtime hours.

### Statistical analysis

To address the primary and secondary aims, a series of 2 (Group: Control vs Intervention) ×3 (Test: baseline, post-assessment, follow-up) repeated measures ANOVA will be utilized. Dependent variables will include the aforementioned measures of physical fitness, bone density, and pelvic floor musculature. The relationship between dependent variables and potential confounding factors (i.e., age, natural childbirth) will be assessed using Pearson's correlation. When relationships exist between confounding factors and dependent variables that are considered moderate or strong (R >0.6), the factor will be added as a covariate to the appropriate ANOVA.

## Discussion

With the increasing aging population, the ability to live independently becomes increasingly important in modern society. New Zealand district health boards spent over $900 million on support services, and specifically residential care, for older people in 2014/2015 alone.[26] It is not just a financial burden on the government but more importantly has detrimental health impacts on the individual and reduces the overall quality of life. People who live in retirement villages and residential care are often away from their former homes and neighborhoods as well as separated from their extended families. It is, therefore, not uncommon for residents to become lonely, which often directly contributes to depression and a reduction in quality of life.[27] Furthermore, a decline in functional fitness has been associated with a decline in overall quality of life.[28] Thus, functional ability is a key factor for older individuals to both maintain independent living and participate in family and community services.[1]

This proposed study aims to improve functional ability in older adults with an innovative and fun exercise program that is new to most people and thus has the potential to increase adherence. The mini-trampoline exercise program has the potential to not only improve physical fitness but also improve specific risk factors in aging women, which include bone health and pelvic floor muscle functioning. Improving any or all of these functions could, in turn, improve the overall quality of life and help to maintain an independent living situation in the older population. The results of this study could help guide the development of exercise intervention for older adults and particularly for older women with specific health risks.

### Implications

This study addresses the health and wellbeing of healthy postmenopausal women, aiming to improve physical functioning and women-specific health risk factors. Extending the knowledge of a mini-trampoline exercise intervention in this population group could potentially improve health benefits in postmenopausal women, increasing their physical function and overall quality of life and decreasing the effects of age-related functional decline.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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