

Original article

Bone turnover increases during supervised treadmill walking in Thai postmenopausal women

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Abstract

Introduction: Treadmill walking is a cheap and attainable form of exercise, which carries a low injury risk and confers other health benefit. The aim of this study is to investigate the effects of 3-month treadmill walking on biochemical bone markers in Thai postmenopausal women.

Material and methods: Thai postmenopausal women participated in a 3-month supervised treadmill walking program. The program consisted of treadmill walking, the intensity of which was 55–70% of maximal heart rate, with duration of 30 min per day, at a frequency of 3 days a week. Crosslinked C-terminal telopeptides of type I collagen (CTX-I) and N-terminal propeptides of type I procollagen (PINP) level were measured at baseline and at 1 week after 3-month training.

Results: Eighteen women completed the training program. The average age of patients was 59.39 ± 4.18 years. The average period after menopause was 9.28 ± 6.52 years. CTX-I and PINP levels at baseline were 0.43 ± 0.14 and 52.15 ± 13.43 ng/ml. CTX-I and PINP levels after 3-month training were 0.80 ± 0.26 and 66.77 ± 22.82 ng/ml. Bone resorption and formation markers were significantly increased after treadmill walking ($p < 0.01$).

Conclusion: Bone turnover increases after 3-month supervised treadmill walking in Thai postmenopausal women.

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Keywords: Bone marker; Menopause; Treadmill walking

1. Introduction

Twenty percent of Thai postmenopausal women were diagnosed as osteoporosis [1]. Weight-bearing exercise is the most important exercise in osteoporosis. Walking is a cheap and attainable form of weight-bearing exercise, which carries a low injury risk and confers other health benefit. It may be an ideal intervention which could prevent further bone loss after menopause. However, the benefit of walking on bone health in postmenopausal women is controversial.

In previous studies, aerobic walking did not prevent bone loss in postmenopausal women [2–4]. On the other hand, high intensity aerobic walking or anaerobic walking preserved bone mineral density in postmenopausal women [5–7]. In a meta-analysis study, regular walking could not preserve bone mineral density at the lumbar spine in postmenopausal women. Although bone mineral density at femur was increased, prevalence of hip fracture in this group was not reduced [8]. A 1 year outdoor aerobic walking could reduce bone turnover marker in postmenopausal women with osteoporosis/osteopenia [9]. Bone turnover also decreased after a 3-month treadmill walking in Thai women [10]. However, only 9 subjects in that study are postmenopausal.

Thai physicians usually advise postmenopausal women to perform aerobic walking exercise. We hypothesize that treadmill walking program may decrease bone resorption and

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increase bone formation markers in postmenopausal women. The aim of this study is to investigate the effects of 3-month treadmill walking with moderate intensity on biochemical bone markers in Thai postmenopausal women.

2. Materials and methods

Thai postmenopausal women were recruited from nearby community and from personnel of our hospital. This study was approved by the institutional ethical committee (IRB no. 95/52, COA 323/2009). Written informed consent was obtained from all participants. Subjects were postmenopausal women who did not perform any exercise more than 3 days per week, body mass index (BMI) within normal range between 18.5 and 25 kg/m² [11], no history of fracture for at least 1 year prior to participation and did not taking agents affecting bone metabolism, such as hormonal replacement; bisphosphonate; corticosteroid; anticonvulsants; vitamin K antagonist; thiazide diuretics and GnRH agonist for at least 6 months before participation [12]. Exclusion criteria included women who had a history of falls and balance problem that precluded safety during treadmill walking, who had metabolic bone diseases such as Paget's disease; hyper- or hypoparathyroidism; thyrotoxicosis; Cushing's disease; multiple myeloma; bone metastasis [12,13], who had chronic diseases affecting bone turnover such as chronic kidney disease and rheumatoid arthritis, who had diseases prohibiting treadmill walking such as knee osteoarthritis with a visual analog scale (VAS) more than 4 cm; low back pain with symptoms aggravated during walking; uncontrolled hypertension; heart disease with American Heart Association functional class C or D. Participants who could not participate at least 80% of exercise session was dropped out.

Treadmill training and physical performance test were set up in the exercise training room of the Department of Physiology, Faculty of Medicine, Chulalongkorn University. The program consisted of 3-month treadmill walking (Nautilus T916 Sport Series LC Display, USA), the intensity of which was 55–70% of maximal heart rate [14], with duration of 30 min per day, at a frequency of 3 days a week. The exercise session included a 5-min warm up, 20-min treadmill walking and a 5-min cool down. All participants were supervised during exercise program. Blood pressure was measured before and after exercise. Heart rate was measured throughout the exercise session using a heart rate monitoring device (Polar, Finland). Participants who had trauma or any complications that prohibited exercise were discharged from the program and were referred to a physician.

Blood samples were collected between 8 and 9 a.m. Subjects were asked to fast overnight and refrain from exercise at least 24 h before blood collection [12]. Biochemical bone markers were analyzed using immunoassay methods with Elecsys kits for Crosslinked C-terminal telopeptides of type I collagen (CTX-I) and N-terminal propeptides of type I procollagen (PINP) (Roche Diagnostics, USA). Bone biochemical marker levels were measured at baseline and after 3-month training. Baseline levels were measured 1 week

before starting the treadmill walking program. Post-training levels were measured at 1 week after the last training session to avoid an acute effect of exercise. Effects of acute exercise on biochemical bone markers persisted as long as 72 h after exercise [15]. Injury according to exercise was recorded throughout the study.

Physical performance test included sit and reach test [16], chair stand test [17] and step test [18]. We assessed the physical performance at 1 week before starting the treadmill walking program and 1 week after the last training session. Sit and reach test was used for measure flexibility of the lower back and the hamstrings. Each subject was tested 2 times. The average value was used for analysis. Greater reach distance determines more flexibility. Chair stand test was used for assess lower limb strength and endurance. The number of repetitions within 30 s was recorded. More repetitions determine better strength and endurance of lower limb muscles. Step test was used for assess cardiovascular fitness. Number of step cycle repetitions in 3 min was recorded and converted to VO₂ (mL/kg/min) [19]. The higher the VO₂ value determines better cardiovascular fitness.

SPSS for Windows version 15.0 was used for statistical analysis with significant level at $p < 0.05$. Demographic data, biochemical bone markers and the physical performance test were reported by mean and standard deviation. The paired *t*-test was used to compare the different of biochemical bone markers and physical performance at baseline and after treadmill walking.

3. Results

Twenty-six postmenopausal women were enrolled. Six participants who had diseases prohibiting treadmill walking were excluded. Two participants were dropped out. One could not participate at least 80% of exercise. One lost follows up. Eighteen women completed the 3-month program. The average age was 59.39 years. The average period after menopause was 9.28 years. The average BMI was 21.99 kg/m². The demographic data of the participants are shown in Table 1.

Baseline CTX-I and PINP levels were 0.43 and 52.15 ng/ml. After 3-month treadmill walking, CTX-I and PINP levels were significantly increased. Biochemical bone markers are shown in Table 2.

At baseline, sit and reach test, chair stand test and step test (convert to VO₂) were 8.58 inches, 17.61 repetitions and 23.10 ml/kg/min, respectively. After 3 months treadmill walking, sit and reach test, chair stand test and step test were 10.06 inches, 20.11 repetitions and 23.47 ml/kg/min. The chair

Table 1
Demographic data of the participants

Age (mean ± SD, year)	59.39 ± 4.18
Height (mean ± SD, cm)	153.78 ± 6.91
Weight (mean ± SD, kg)	52.34 ± 6.55
BMI (mean ± SD, kg/m ²)	21.99 ± 2.32
Duration after menopause (mean ± SD, year)	9.28 ± 6.52

Table 2
Biochemical bone markers level before and after 3-month treadmill walking

Biochemical bone marker	Baseline	After 3 months	P
CTX-I (mean \pm SD, ng/ml)	0.43 \pm 0.14	0.80 \pm 0.26	0.001
PINP (mean \pm SD, ng/ml)	52.15 \pm 13.43	66.77 \pm 22.82	<0.001

CTX-I: Crosslinked C-terminal telopeptides of type I collagen.

PINP: N-terminal propeptides of type I procollagen.

stand test score was significantly increased after treadmill walking ($p = 0.02$). The sit and reach test and step test score were not significantly changed ($p > 0.05$). Body weights and BMI after the 3-month treadmill walking were 52.37 kg and 22.06 kg/m². There were not significant difference from baseline ($p > 0.05$). Physical performance, body weight and BMI are shown in Table 3.

4. Discussion

In our study, bone turnover markers level increased during 3-month supervised treadmill walking program in Thai postmenopausal women. We measured biochemical bone markers level at 1 week after the last training session to avoid an acute effect of exercise that persisted as long as 72 h [15]. However, bone turnover markers level still increased.

The exercise program in our study was too short duration and less frequency and intensity to give the positive results. Bone resorption and formation markers level were maintained after 7 months of anaerobic walking with duration of 30 min per day and frequency of 3 days a week [7]. Bone resorption marker level was decreased after 12 months walking with 50% of maximum oxygen consumption, duration of 1 h a day and frequency of 4 days a week [9]. In a recent study, bone resorption marker level of Thai women was decreased after 3-month treadmill walking at 50% of heart rate reserve, duration of 30 min per day and frequency of 3 days a week. Only 9 Thai postmenopausal women included in that study [10]. In our study, although bone turnover increases after treadmill walking, but we cannot conclude this change depends on this exercise alone. Other factors such as age and postmenopausal period may affect bone turnover. More intensity, frequency and duration may need to gain benefit on bone health.

Physical performance was measured at baseline and after 3-month treadmill walking. The sit and reach test represented flexibility of the lower back and hamstring. Baseline flexibility of our participant was categorized in low level according to Thai normative data [20]. No significance changed was found

Table 3
Physical performance and body mass index before and after 3-month treadmill walking

Physical performance test	Baseline	After 12 week	P
Sit and reach test (mean \pm SD, inch)	8.58 \pm 2.37	10.06 \pm 2.44	0.07
Chair stand test (mean \pm SD, repetition)	17.61 \pm 4.83	20.11 \pm 13.62	0.02
Step test, Calculated VO ₂ (mean \pm SD, ml/kg/minute)	23.10 \pm 4.23	23.47 \pm 5.09	0.50
Body weight (mean \pm SD, kg)	52.34 \pm 6.91	52.37 \pm 6.90	0.95
Body mass index (mean \pm SD, kg/m ²)	21.99 \pm 2.32	22.06 \pm 2.18	0.70

after exercise. Baseline chair stand test was within normal range [20]. There was significantly improved after exercise as same as the results from previous study [21]. Therefore a lower limb strength and endurance were improved. The baseline step test was within normal range [20]. There was not significantly improved after exercise.

Body weight and BMI at baseline were not significantly change after 3-month treadmill walking. We did not instruct participants regarding diet control or other weight control strategies. Twenty percent of participants had minor injury, such as a mild degree of muscle strain or soreness during treadmill walking. No participants were dropped out due to injury.

There are some limitations in our study. First, no control group was included in this study. Second, biochemical bone markers level could detected pharmacotherapy effects within 1–3 months post treatment. It may be too earlier to detect effects of exercise program in the first 3 months by bone marker level. It may represent the positive effect of exercise if treadmill walking period is more than 3 months. Finally, the results in our study cannot use for all postmenopausal women. The average age of our participant is nearly 60 years old with wide range of age. Rubin et al. reported aging alters the response of skeleton tissue to mechanical loading [22]. Age may affect the response to treadmill walking in our study. The average postmenopausal period in our study is nearly 10 years with wide range of postmenopausal period. It will cause different status of bone turnover markers due to quite different phase of estrogen deficiency. However, 70% of participant was menopause less than 10 years.

5. Conclusion

Bone turnover increases after supervised treadmill walking in Thai postmenopausal women. Moderate intensity aerobic treadmill walking thrice a week for 3 months could not suppress bone turnover rate.

Conflicts of interest

None.

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