

## Effects of Six Months Group-Based Exercise on Bone Mineral Density and Functional Physical Fitness in Early Postmenopausal Women

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### Abstract

**Purpose:** To investigate the changes in bone mineral density (BMD) and functional physical fitness (FPF) of early postmenopausal women (PMW) following a 6 months of group-based exercise (either resistance training [GBRT] or group-based step aerobics exercise [GBSA]). **Methods:** Fifty-one healthy PMWs (50-65 years) were randomly divided into the GBRT, GBSA, or control (CON) groups (n = 17 per group). The GBRT (60% of 1RM) and GBSA (55-85% of heart rate reserve) groups performed 60 min per session, 3 times a week for 6 months, whereas subjects of the CON group continued with their normal daily activities and did not receive any intervention. The BMD and FPF (i.e., strength of lower extremity, agility/dynamic balance, and cardiovascular endurance) were assessed before and after 6 months. **Results:** The results showed that the BMD at the femoral neck of the GBSA group was significantly improved (2.74%) compared to the CON group (-2.38%) ( $p < .05$ ), but not in the GBRT group (0.23%). At the lumbar spine, there were no significant changes in BMD amongst three groups. The functional physical fitness was significantly improved in both GBRT and GBSA intervention groups after the 6-month training compared with the CON group ( $p < .05$ ). **Conclusion:** These results suggested that group-based exercise is beneficial in preventing bone mineral loss and improving functional physical fitness of the PMW. However, GBSA exercise seems to be more effective in preventing bone mineral loss at femoral neck than GBRT exercise.

**Keywords:** step aerobics, resistance training, bone mineral loss, strength, femoral neck

## 六個月團體運動訓練對早期停經後女性骨質密度與功能性體能之效果

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### 摘要

**目的：**探討6個月團體運動（阻力訓練 [group-based resistance training, GBRT] 或階梯有氧 [group-based step aerobics, GBSA]）對停經後女性（postmenopausal women, PMW）骨質密度

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(bone mineral density, BMD) 與功能性體能 (functional physical fitness, FPF) 之變化率。方法：51位健康PMW隨機分派至GBRT、GBSA、或對照 (CON) 三組 (每組17人)。GBRT (60%最大反覆) 與GBSA (55-85%心跳保留率) 接受每週3次、每次60分鐘，持續6個月運動，CON則維持正常不做任何介入。BMD與FPF (如下肢肌力、敏捷／動態平衡與心肺耐力) 在6個月介入前、後進行評估。結果：股骨頸BMD在GBSA組 (2.74%) 顯著優於CON組 (-2.38%)，但GBRT組 (0.23%) 無顯著。在腰椎BMD三組間無差異；FPF在GBRT與GBSA 6個月訓練後顯著優於CON組。結論：此結果建議團體運動介入可預防停經後女性骨質流失並能有效提升FPF。團體階梯運動對股骨頸骨質流失的預防效果似乎比阻力訓練更有效。

**關鍵詞：**階梯有氧、阻力訓練、骨質流失、肌力、股骨頸

## Introduction

The average life expectancy for women in Taiwan is 83.2 years (Ministry of the Interior, 2015) and women reach menopause at the average age of 49 years (Chow, Huang, & Lee, 1997). Therefore, more than 30 years of a woman's life in Taiwan is in the postmenopausal stage. Previous studies reported that menopause is associated with a decline in estrogen levels, which could lead to an increase in visceral adiposity and a decrease in bone density, muscle mass, and muscle strength (Fragala, Kenny, & Kuchel, 2015; Messier et al., 2011). The incidence of osteoporosis in Taiwan increased from 1.13% in the 21-30-year-old age group to 54.55% in those over 80 years of age (Lin, Chen, Chang, & Ho, 2001). In addition, the rates of decline in leg strength averaged 14% to 16% per decade after age of 45 years old. And the change in leg strength was directly associated with the change in muscle mass (Hughes et al., 2001). Furthermore, a rapid bone loss rate occurred in women within the first five years after menopause (Bjarnason, Hassager, Ravn, & Christiansen, 1995). Both fat body mass and lean body mass were correlated with bone mass (Compston, Bhambhani, Laskey, Murphy, & Khaw, 1992).

Adverse effects of menopause include rapid bone loss and functional fitness conditions that affect women's quality of life.

Hormone replacement therapy (HRT) has been frequently advocated (Ravnikar, 1987) to treat menopause symptoms such as hot flashes and insomnia. However, some menopausal women are unwilling to undergo HRT because of the overall negative risk-benefit ratio (example of breast cancer) (Palacios, 2008). Alternatively, exercise intervention studies showed positive outcomes to prevent, maintain, and improve postmenopausal-induced adverse effects, like muscle strength (Wen & Chen, 2012) and bone health (Marques et al., 2011; Wen, 2006). It is important for postmenopausal women (PMW) to maintain a good quality of life and better health as they progress to older adulthood.

Recent studies have suggested that regular physical activity and exercise should be introduced into the lifestyle of PMW to decreased severity of flushes decreased by 92% and enhance their quality of life (Wen & Chen, 2012), and exercise should be introduced gradually to ensure compliance (Lindh-Astrand, Nedstrand, Wyon, & Hammar, 2004). However, participating in a group-based class has a more cohesive effect compared with individual members in attending a cycle ergometer training group (Kerschman-Schindl et al., 2002). Cyarto, Brown, Marshall, and Trost (2008) found both home- and group-based progressive resistance training programs and a group walking program able to improve functional performance in retirement village residents. Although the results

suggested that group-based exercise intervention could sustain participation in middle-aged and older adults, these studies focused on either group-based resistance and aerobics exercise or a combination of resistance, agility, and stretching interventions. Based on the position stand of American College of Sports Medicine (ACSM) (Kohrt, Bloomfield, Little, Nelson, & Yingling, 2004) on physical activity and bone health in adult, endurance activities with moderate-to-high levels of weight bearing were recommended for maintaining or promoting bone mass. This exercise mode improves cardiovascular endurance, skeletal muscle functions, and bone health. Among various weight-bearing exercises, step aerobics exercise program seems to be relatively efficient in space and equipment required when compared other exercises (e.g., running, resistance training). A group-based exercise program with diverse training modes may improve adherence along with bone health and functional physical fitness in PMW.

The study of Martyn-St James and Carroll (2009), examined the effects of group-based exercise on bone mineral density and physical fitness in PMW, found that 8 months resistance-training increased BMD at total hip (1.5%) in PMW. Furthermore, a meta-analysis study advocated that structured resistance exercise programs and low-impact exercise along the sagittal plane of movement, such as stair climbing, are potentially preserved BMD at the lumbar spine and femoral neck in PMW (Martyn-St James & Carroll, 2009). Structured group-based resistance training (GBRT) and group-based step aerobics (GBSA) interventions have diverse implications and to be interesting to participants; however, no previous study has systemically examined the effects of the structured GBRT and GBSA programs on both changes of BMD and functional physical fitness (FPF) in early PMW. Therefore, we

hypothesized that 6 months of GBRT and GBSA interventions would significantly improve BMD and FPF in early PMW compared with a control group.

## Methods

### 1 Study Design and Participation

This was a randomized and control trial study. And, procedures of this study have been reviewed and approved by the Chang Gung memorial hospital Institutional Review Board (No. 94-034). This study was advertised in local newspaper, radio program and during public lectures in Hualien County, Taiwan. A total of 75 early PMWs (50-65 years old) volunteered for this study. However, 22 of them were excluded based on the following criteria: known osteoporotic fractures, currently on medication and had health problems that affecting bone metabolism, on HRT, a history of cardiovascular disease, and smoking. A total of 53 qualified sedentary PMWs were randomly assigned into GBRT, GBSA, or control (CON) groups. The written informed consent was obtained from each participant prior to the beginning of the study. Two participants withdrew before the start of exercise interventions due to lack of time. Finally, 51 participants completed this study.

Participants in the GBRT and GBSA groups were asked to attend group-based exercise intervention three times a week (60 min each session) for 6 months, and participants in the CON group were asked to maintain their regular daily dietary intake and lifestyle. Additionally, participants were requested to inform investigators if they experience from any adverse event before, during, or after exercise sessions. There were no exercise- or assessment-related adverse events reported during the study duration.

## 2 Group-Based Exercise Interventions

Two forms of exercise were introduced for group-based exercise training. All exercise training sessions were led by the same instructor. All training sessions were conducted in an aerobics classroom at the Tzu-Chi University. The group-based exercise training consisted of 1 h exercise sessions 3 times a week on alternate days for 6 months. The 1 h course of training session consisted of warm-up (8-12 min), exercise training (40-45 min), and cool down (5-10 min) sessions. Exercise training was accompanied by an appropriate music.

### 3 Resistance Exercise Program for GBRT Group

GBRT intervention was adopted and modified from previous studies (Pearl, Moran, & Golueke, 2001). The participants performed a group-based, diverse resistance training using apparatus (such as elastic bands, dumbbells, Swiss balls, and body bars) with a focus on major muscle groups. Ratings of perceived exertion (RPE) scales were used to monitor the intensity as all participants were new to resistance training (Earle & Baechle, 2004). Dynamic and static upper and lower extremity stretches were performed during the warm-up sessions. The resistance training program were divided into two phases. The first phase exercise training focused on adaptation during week one and two. At the start, all participants familiarized themselves with the exercise movements without using weight. Then, they progressed to complete one set of 15-20 repetitions for each given exercise at approximately 50-60% of their 1RM by the end of the first phase (Bocalini, Serra, dos Santos, Murad, & Levy, 2009; Pearl et al., 2001). Intensity of exercise was monitored using a RPE of 11 to 13 (Earle & Baechle, 2004). The second

phase was focused on improving muscular endurance and strength. The resistance load was gradually increased using respective resistance training apparatus until participants could perform two to three sets of 12-15 repetitions at approximately 60-70% of their 1 RM (Pearl et al., 2001). Resistance exercises included lunges (front, back, sideways), squats, leg adductions, leg abductions, chest presses, elbow flexions, elbow extensions, upper back rows, and abdominal flexions (Pearl et al., 2001). The upper and lower body exercises were performed alternately to minimize fatigue, without any pause between repetitions and one minute rest between sets. Each exercise training session was guided by the same instructor/researcher and two research assistants.

### 4 Step Aerobics Exercise Program for GBSA Group

The step aerobics exercise is a weight-bearing endurance exercise, eliciting ground reaction forces, which was based on the ACSM recommendation (Kohrt et al., 2004). Target intensity for all sessions was set at 55-85% of the heart rate reserve (HRR). The training intensity of the program was monitored using telemetry heart rate monitor (S810, Polar, Kempele, Finland). Heart rate was recorded at every 5 min interval. In brief, the step aerobics training choreographies included conventional basic step, "V" step, "L" step, and "A" step for both the right and left sides, alternating step knee-lift sequences, alternating leg up-up-down-down patterns, and step kicks. Arm movements such as bicep curls and lateral raises at the shoulder level and above the head were integrated concurrently with the selected step exercise. The musical cadence of all sessions was set between 120 and 125 beats per min. At the initial stage, the height of the step was set at 10 cm and subsequently elevated to 20 cm when intensity was no longer in the desired range.

## 5 Measured Variables

### (1) Bone Mineral Density (BMD)

BMD of the lumbar spine (L2-L4) and right femoral neck were measured using DXA (Norland XR-36, Norland, Fort Atkinson, WI) at baseline and 6-months post-intervention. Scanning instructions and procedures were standardized for all participants. Participants wore a hospital gown and removed all jewelry and all other clothing. The lumbar spine (L2-L4) and right femoral neck were scanned and analyzed by the same qualified technician. To minimize the variability between pre and post measurements, participant positioning, anatomical landmarks, and scan speeds were recorded for each participant during the baseline evaluation and used as a reference for the post-intervention scan. Calibration was conducted using the manufacturer's spine phantom with a known hydroxyapatite density. The categorization of bone health status was based on the criteria given by the World Health Organization (WHO) on T-score of femoral neck;  $-2.5$  or lower = osteoporosis,  $-1.0$  and  $-2.5$  = osteopenia, and  $> -1.0$  or higher = normal bone health (Black et al., 2000).

As BMD is an areal scan, a person's height can be used to correct for BMD outcomes influenced by body size (Khosla, Atkinson, Riggs, & Melton, 1996). Therefore, the individual's height was used to normalize BMD value (BMD/height in meter) before comparison analysis between individuals was carried out.

### 6 Functional Physical Fitness (FPF) Tests

PMW faced many physiological changes that may lead to loss of FPF. The rationale of functional physical fitness such as having the physical capacity to perform normal everyday activities safely and independently, was

examined with the tests on agility/dynamic balance (8-feet up-and-go), muscular strength in lower extremity (chair stand test), and cardiovascular endurance (6 min walk test) (Asikainen, Kukkonen-Harjula, & Miilunpalo, 2004). These FPF tests were adopted from the study of Rikli and Jones (2001).

#### (1) 8-Feet Up-and-Go

The 8-ft up-and-go test was used to assess agility/dynamic balance. After a demonstration by the test administrator, participants conducted one practice trial followed by two trials with 1 min of rest between the trials. The score used in this analysis was the shortest time for the test (i.e., from a seated position, walk 0.31 m (8 ft), turn, and return to the seated position), measured to the nearest 1/10th of a second.

#### (2) 30-Second Chair Stand

The 30-second chair stand test was used to assess lower body strength. After a demonstration by the test administrator, participants had two practice trials, followed by two 30-s test trials with 1 min of rest between the trials. The score was the total number of stands executed correctly within 30 s. The best score of the 2 trials was used in the final analysis.

#### (3) 6-Minute Walk Test (6-MWT)

The 6-MWT was used to assess cardiovascular endurance. After an explanation regarding test procedures and a demonstration by the test administrator, participant conducted the walk at the fastest speed possibly when instructed to "Go." The test was stopped after six minutes. The score used in the analysis was the total distance walked in 6 min along a 54.4 m rectangular course, which was marked at every 3.0 m.



## 7 Physical Activity Questionnaire

All participants recalled their physical activities according to the physical activity questionnaire (PAQ) (Pols et al., 1995) as interviewed at baseline and after 6 months. The questionnaire consists of three sections. Section one asks about their physical activity patterns at home, Section two is about travel patterns to work and activity at work. Section two may be skipped by people who have not worked. The last section asks about recreational activities and engaged in sports and leisure activities. Final scores were tabulated, and the total physical activity of each participant was determined based on all three parts.

## 8 Statistical Analysis

The data was displayed as mean and standard deviation. The pre-post changes of the measured variables were express as percentage of change. One-way analysis of variance (ANOVA) was conducted to compare the pre-post changes between the three groups. If there was a significant difference in the pre-post changes between groups, post-hoc Bonferroni follow-up test was used to locate the changes that are statistically different.  $P$  value  $< .05$  was considered statistically significant.

## RESULTS

### 1 Subject Characteristics

The characteristics of the participants are shown in Table 1. There were no significant ( $p < .05$ ) differences in age, weight, and year since menopause amongst the three groups (Table 1). However, there was a significant difference in height and body mass index between the GBRT and CON groups. The status of bone health distribution among the three groups was shown in Table 2. There was no statistical difference in their bone health status.

### 2 Bone Mineral Density (BMD)

The BMD of the femoral neck and the lumbar spine at the baseline and after six months intervention is shown in Figure 1. The results indicated that no reduction in BMD of the femoral neck and lumbar spine for both exercise groups, but there was a reduction in BMD for the control group. Statistical analysis show that there was a significant difference in changes of BMD at the femoral neck in GBSA group (2.74% of improvement) compared to control group (2.38% reduction), but not in the GBRT group (0.23%). However, there was no significant difference in the changes at the lumbar spine between the three groups (Figure 1).

**Table 1. Characteristics of participants**

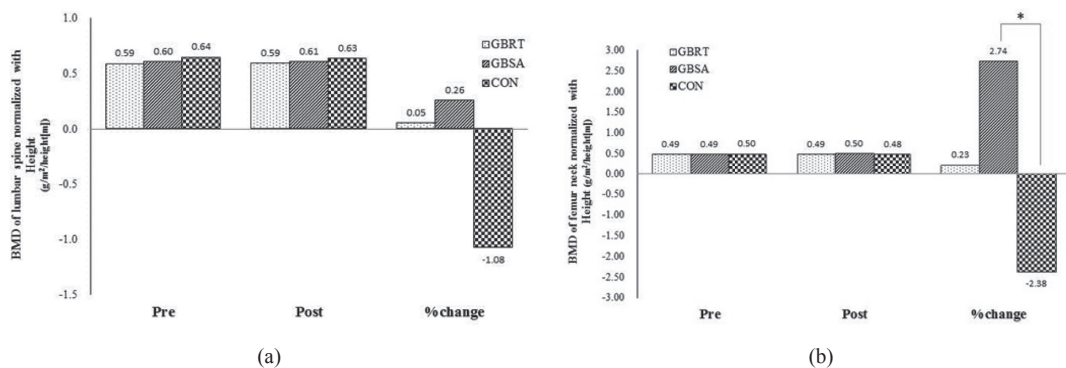
Variables	Group		
	GBRT (n = 17)	GBSA (n = 17)	CON (n = 17)
Age (year)	54.3 $\pm$ 0.9	54.3 $\pm$ 0.8	56.1 $\pm$ 1.0
Height (cm)	156.3 $\pm$ 1.0*	153.1 $\pm$ 0.8	152.7 $\pm$ 1.1
Weight (kg)	55.0 $\pm$ 1.3	54.6 $\pm$ 1.5	57.7 $\pm$ 1.7
BMI (kg/m <sup>2</sup> )	22.5 $\pm$ 2.0*	23.3 $\pm$ 0.7	24.8 $\pm$ 0.7
Age of first period (year)	14.9 $\pm$ 0.4	14.1 $\pm$ 0.4	14.9 $\pm$ 0.5
Year since menopause (years)	4.4 $\pm$ 1.0	4.5 $\pm$ 0.7	7.0 $\pm$ 1.5
Exercise Attending rate (%)	92.2 $\pm$ 2.9	92.1 $\pm$ 1.8	-

Note: All values are mean  $\pm$  SEM. \* indicates a significant difference ( $p < .05$ ) compared with CON group. BMI: body mass index. GBRT: group-based resistance training; GBSA: group-based step aerobic exercise; CON: control groups.

**Table 2. Bone health status of participants**

Bone health status		Group		
		GBRT (n = 17)	GBSA (n = 17)	CON (n = 17)
Healthy	Number	10	11	12
	Percentage	58.80%	64.70%	70.60%
Osteopenia	Number	7	6	3
	Percentage	41.20%	35.30%	17.60%
Osteoporosis	Number	0	0	2
	Percentage	0.00%	0.00%	11.80%

Note: GBRT: group-based resistance training; GBSA: group-based step aerobic exercise; CON: control groups.



**Figure 1. The pre, post, and percentage change of BMD at the lumbar spine (a) and femoral neck (b) during the 6 months intervention. (a) There was no significant difference in the changes at the lumbar spine between the three groups. (b) There was a significant difference in changes of BMD at the femoral neck in GBSA group (2.74% of improvement) compared to control group (2.38% reduction), but not in the GBRT group (0.23%).**

Note: GBSA: group-based step aerobics group; GBRT: group-based resistance training group; CON: control group.

### 3 Functional Physical Fitness

The results showed that all functional physical fitness components (agility/dynamic balance, muscular endurance in lower extremity, and cardiovascular endurance) were significantly improved in both GBRT and GBSA groups compared with the CON group ( $p < .05$ ) (Table 3).

The percentage changes in physical activities in both GBRT group (pre:  $35.29 \pm 2.21$  points, post:  $43.82 \pm 1.52$  points, change 35.29%) and the GBSA group (pre:  $38.94 \pm 1.70$  points, post:  $43.12 \pm 1.57$  points, change

15.31%) demonstrated that the involvement of participants in physical activities were significantly increased, but there was a reduction in physical activity in CON group (pre:  $37.25 \pm 2.12$ , post:  $35.15 \pm 3.19$  points, change -16.19%) after the 6-month intervention.

### DISCUSSION

The present study demonstrated step aerobics exercise and resistance training, both are beneficial to early postmenopausal women in term of bone health and functional physical fitness. However, GBSA showed more effective

**Table 3. Functional physical fitness of the participants before and after the 6 months interventions**

Variables	Groups	Pre	Post	% change	<i>p</i> value
8-ft up-and-go (second)	GBRT	4.83 ± 0.12	4.25 ± 0.11	10.80 ± 2.41*	.006
	GBSA	4.97 ± 0.10	4.29 ± 0.11	12.50 ± 2.18*	
	CON	5.58 ± 0.20	5.42 ± 0.62	0.27 ± 3.52	
Chair stand (repetition)	GBRT	16.25 ± 0.66	21.31 ± 0.86	30.57 ± 5.44*	.008
	GBSA	18.77 ± 1.57	20.87 ± 1.11	26.61 ± 8.23*	
	CON	21.84 ± 1.30	19.00 ± 0.86	-5.92 ± 11.18	
6-min walk (meter)	GBRT	660.8 ± 13.0	623.8 ± 10.5	7.09 ± 1.88*	.000
	GBSA	704.4 ± 9.7	639.4 ± 14.6	6.29 ± 1.89*	
	CON	679.1 ± 11.0	639.8 ± 9.6	-3.80 ± 1.62	

Note: \* significant ( $p < .05$ ) difference in changes of percentage compared to CON group.

on the improvement of BMD at the femoral neck compared to GBRT, whereas there was no significant difference in BMD at the lumbar spine after 6 months of the respective exercise training. These findings were consistent with previous studies (Kohrt et al., 2004; Welsh & Rutherford, 1996). According to the ACSM position stand of physical activity and bone health in adult (Kohrt et al., 2004), weight-bearing endurance activities and resistance training with moderate-to-high levels were recommended to maintain or promote bone mass. This type of training is not just beneficial for cardiovascular and skeletal muscle functions but also for bone health. Among various weight-bearing exercises, step aerobics exercise program seems to be relatively efficient in space and facility requirement when compared with other exercises (e.g., running, resistance training). Participating in a group-based class has a more cohesive effect on the attending rate (Kerschman-Schindl et al., 2002). Group-based exercise with good supervision and adherence resulted in a high attendance rate ( $92.1 \pm 1.8\%$ ) that is one of the strong and important components presented from this study.

Present study demonstrated a similar outcome with previous studies, only GBSA exercise resulted a significantly improve in

BMD of the femoral neck but not in resistance training (Figure 1). Welsh and Rutherford (1996) also reported that men and women (aged 50-73 years) who attended a high-impact exercise regimen 2 to 3 times a week for 12 months increased BMD of the femoral neck by 1.57% while BMD in CON group decreased -1.9% ( $p = .049$ ). However, they found that lumbar spine BMD did not change in either group after following a regimen that included stepping and jumping exercises designed to load the proximal femur and spine. A meta-analysis study advocated that resistance-alone protocols produced a nonsignificant positive effect (Zhao, Zhao, & Xu, 2015). Conversely, the 6-month GBSA intervention in this study resulted in a significant improvement in BMD at the femoral neck (Figure 1). In addition, Chan et al. (2004) studied on PMW participated in Tai Chi Chun for 12 months which is a low-impact exercise. Their results showed that both exercise group and control group experienced in bone loss at femoral neck after 12 months (-0.9% vs. -1.8%). However the bone loss in the exercise group was significantly slower than that in control group (Chan et al., 2004). This could be due to the low vertical mechanical loading of the exercise on bone.

Exercise studies on BMD have site-specific outcomes and are related to the types



of exercise performed. Similarly, the animal studies (Notomi, Okimoto, Okazaki, Nakamura, & Suzuki, 2003) have also suggested that exercise induced bone formation is site specific and dependent on the type of exercise and load applied to the bones. In this study, the results of BMD at femoral neck (0.23%) in GBRT group after 6 month of resistance training were increased less than the study of Marques et al. (2011) that underwent 8 months resistance-training increased in BMD at total hip (1.5%). The possible reasons for the level improvement might relate to the different intervention protocols and the site. Other possible reasons for the levels of improvement in BMD might be associated with the ethnicity, age, and BMI of the participant. BMD have been reported to be lower in Asian compare to Caucasian adults (Tobias, Cook, Chambers, & Dalzell, 1994; Walker et al., 2006). These racial differences may be resulted from the differences in lifestyle, such as food intake and physical exercise (Nohara, Kamei, & Ohta, 2006). The participants in the study conducted by Marques et al. (2011) were all Caucasian elderly (mean age 68.5 and an age range of 60-95 year-old) women with higher BMI (mean BMI = 28.1). The change rate of BMD at the femoral neck from the resistance exercise group, aerobics exercise group and control group were -1.2%, 0.5%, and -0.3%, respectively. Also, the most rapid bone loss rate in women is in the first five years after menopause (Bjarnason et al., 1995) and would decline to 1% annually after age 65.

Although there is a slight enhancement in the BMD at lumbar spine, it is not as pronounced as that in the femoral neck. The different effects observed in the lumbar spine and femoral neck could be attributed to our exercise programs that did not stress the lumbar spine as much as the femoral neck. Consequently, a smaller effect was observed in the lumbar spine compared

to the femoral neck. Several studies did show increases in lumbar spine BMD following high-impact exercises (Chien, Wu, Hsu, Yang, & Lai, 2000; Dalsky et al., 1988), but not for aerobic exercise training on lumbar spine BMD (Caplan, Ward, & Lord, 1993; Marques et al., 2011; Martin & Notelovitz, 1993). Similarly, our study also demonstrated minimal increase (0.2%,  $p > .05$ ) in lumbar spine BMD in both the GBSA and GBRT groups, whereas the BMD in the CON group reduced by 1.2%. This showed that despite the non-significant increase in lumbar spine BMD, both of our intervention exercises could be used to slow down the loss of bone density at the lumbar spine. The exact bone strain of mechanical loading on the bone sites by these endurance exercises should be studies in further detail.

The functional physical fitness indices, including the 8-feet up-and-go, chair stand test, and 6 min walk test were significantly improved following the 6-month of GBRT (10.80%, 30.57%, and 7.09%) and GBSA (12.50%, 26.61%, and 6.29%) interventions compared with the CON group (0.27%, -5.92%, and -3.8%) (Table 3). These results were similar to previous study findings (Hallage et al., 2010; Wen, Li, & Chuang, 2014). The results supporting our hypothesis the 6 months of GBSA and GBRT interventions could produce a higher FPF than the CON group. Our results are supported by the findings of previous studies (Hallage et al., 2010; Wen et al., 2014). Hallage et al. (2010) found that a 12-week GBSA training program that included 3 training sessions per week for 30-60 min per session at 50-70% HRR significantly improved the chair stand test, 8-feet up-and-go, and 6 min walk test in healthy older women. Thus, functional physical fitness maintenance (e.g., muscular strength) is crucial for older adults to retain independent motor abilities (Buchman et al., 2007).

The potential limitations and weaknesses of present study were 1. did not determine the bone turnover, we cannot know whether the changes of the BMD match with the bone turnover; 2. our participants were early PMW with normal BMIs, the results may not representing the general population of PMW such as obese PMW; 3. The dietary on calcium intake and the body calcium levels of the participants were not monitored.

## CONCLUSION

This study showed that a training group following 6 months of group-based step aerobics had significant improvements in their BMD at the femoral neck compared to the control group, but no significant difference was found at the lumbar spine among the GBRT, GBSA, and CON groups. The agility/dynamic balance, muscular strength of lower extremity, and cardiovascular endurance had significantly improved following the 6-months GBRT and GBSA compared with the CON group. As our GBSA intervention has low operational costs and easy applicability, and can be performed by many people of different fitness levels simultaneously, it can be implemented within any community center. Therefore, the results of this study suggest that GBSA interventions are effective at preventing bone loss at femoral neck in PMW, and that both GBRT and GBSA could improve muscle strength, agility, and aerobic capacity.

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