Effects of Low Impact Aerobic Dance and Fitball Training on Bone Resorption and Health-Related Physical Fitness in Thai Working Women

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Objective: *To investigate the effects of low impact aerobic dance and fitball training on bone resorption in Thai working women.*

Material and Method: *The samples of this study consisted of 47 females at the age from 35-45. The subjects were divided into two groups: A) 23 females in a low impact aerobic dance (20 min) and fitball (15 min) training group, and B) 24 females in a low impact aerobic dance training group (35 min). Both groups wore a heart rate monitor during the exercise training. The sessions in the training program over 12 weeks were performed a 3-day a week, 35-minute for work out per session at an intensity of 60-80% of maximum heart rate. Before and after the 12-week training program, bone resorption (Telopeptidecrosslinked: β-CrossLaps) and bone formation (N-terminal propeptine of procollagen type 1: P1NP) including physiological and fitness data were assessed. The data of pre and post trainings within and between the groups as well as the data of changes in dependent variables were compared and analyzed by using paired t-test and independent-test. The statistically significant difference was set at the 0.05 level.*

Results: *Both the low impact aerobic dance and fitball training group and the low impact aerobic dance training group revealed their lower level of bone resorption (β-CrossLaps) while the first group showed statistically significant change ($p<0.05$). In addition, there were no significant changes of bone resorption (β-CrossLaps) and bone formation (P1NP) between these two groups. However, both groups had not only a significant decrease in resting heart rate, systolic and diastolic pressure, but also an increase in muscular strength and endurance and maximum oxygen uptake when the training was completed. Flexibility of the group with fitball was increased significantly ($p<0.05$).*

Conclusion: *Low impact aerobic dance and fitball training has the positive effect of slowing down bone resorption and is beneficial to healthy bones. They concurrently increase lower back flexibility.*

Keywords: *Low impact aerobic dance and fitball training, Bone resorption (Telopeptidecrosslinked: β-CrossLaps or CTx), Health-related physical fitness*

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When women reach 30 years old, their bone mass slowly maintains the constant level. With advancing age, bone resorption outpaces bone formation[1]. The determinants of osteoporosis are a decrease in estrogen[2], smoking[3], and lack of exercise[4]. "Osteoporosis" is a condition in which an imbalance between bone formation and resorption occurs. World Health Organization[5] defines osteoporosis as a condition of decreasing bone mass density and bone structure deterioration causing fragile bones and the risk of fracture.

Many researchers in the recent studies[6-10] found effective ways of osteoporosis prevention and preservation. Exercise is an alternative way to prevent osteoporosis. The easiest way to prevent osteoporosis is that sedentary lifestyle should be converted. Furthermore, high impact exercise like aerobic and weight-bearing exercise increases bone density and prevents or reduces age-related bone loss[11,12]. Weight-bearing stimulus can be produced by both resistance exercise and aerobic exercise. In addition, forces which are greater than people experience in daily living activities are required for improving bone mass[6]; weight-bearing yoga can slow the breakdown of bone mass[13]. In 2011 Tantiwiboonchai, Kitpet and Yuktanandana[7] found that walking exercise with

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and without weighted vests affected the change of bone formation, bone resorption and physical fitness. Kohrt, Ehsani and Birge[8] demonstrated that an exercise program including walking, jogging and stair climbing resulted in significant increases in bone mineral density of the whole body, lumbar spine and femoral. The fitball or the stability ball was also proved that it could increase flexibility, muscle strength and endurance, static and dynamic balance and functional performance[14]. Aerobic dance training and fitball is considered to be weight-bearing from aerobic dance training, strengthening and balancing from fitball.

Swiss-balls, i.e. fitball, gym ball, or stability ball are used in many different areas such as strength training, balancing training, orthopedic rehabilitation, physical fitness, flexibility training, physical education classes and specific education[15]. Sekendiz, Cug, and Korkusuz[16] showed the results of the 12-week Swiss-ball core strength training on strength, endurance, flexibility, and balance applied to sedentary woman for 3 days a week for 45 minutes. They indicated significant improvement in the muscular strength, muscular endurance, flexibility and balance. Corbett, Mclaughlin, and Herman[17] stated that Swiss-ball training increased balance in older adults. Khumprommarach and Kritpet[18] found that aerobic dance program with mini fitball improved flexibility, cardiorespiratory system, strengthening and quality of life in working women. Therefore, the researchers here are interested in low impact aerobic dance training and fitball, which is safe training and suitable for all ages. This research is designed for low impact aerobic dance and fitball training and will cause observable changes in bone resorption and physical fitness.

Material and Method

Purpose of the study

The aim of this study was to investigate the effect of low impact aerobic dance and fitball training on bone resorption in Thai working women.

Subjects' selection and criterion

The experimental protocol was approved by the Ethic Committee for Research Involving Human Research Subjects Health Science Group, Chulalongkorn University, Thailand. All participants gave their written informed consent. The volunteered participants were forty-seven working women. They were divided into two groups: A) 23 females in the low impact aerobic dance and fitball training and B) 24 females in the low impact aerobic dance training. The inclusion criteria included sedentary lifestyle of people at the age 35-45, not a smoker, not a consumer of any alcoholic beverages, not a patient taking hormone replacement therapy, consuming tea or coffee not more than 2 standard cups per day (250 cc/cup), doing exercise not more than 2 times per week, not being diagnosed with osteoporosis (BMD) not less than (-2.5 SD), no osteoarthritis and heart disease. The subjects would be excluded if they wanted to drop out or did not complete exercises more than 2 weeks continuously or had a personal problem during the experiment.

Instrument and data collection

This research was a quasi-experimental design. Questionnaires to assess general health were distributed and the SAHARA® BMD was used to measure the heel bone mineral density (BMD).

The general physiological testing tools consisted of weight and body mass index using the bioelectrical impedance analysis (220 model, Inbody) from South Korea and blood pressure monitor (SEM-1 model, Omron) from Japan. Flexibility was measured by using sit and reach test and leg strength and endurance by using 1-minute chair sit to stand test. Maximum oxygen uptake was measured by modified Balke treadmill test. Bone formation and bone resorption were measured by using electrochemiluminescence immunoassay (ECLIA) on a Cobas® "e411" brand Germany, β-Crosslaps biochemical and P1NP biochemical testing of Roche Diagnostics (Thailand) Co. Ltd. at Chulalongkorn Hospital. Blood samples of 3 cc at median cubital vein were collected 8.00-9.00 AM by medical technologist, Faculty of Allied Health Sciences, Chulalongkorn University. The low impact aerobic dance and fitball training group and the other low impact aerobic dance training group were wearing heart rate monitor during exercise by using "Polar" brand model "M53" from Finland. The low impact aerobic dance and fitball training group were exercised with Jason brand fitballs from America.

Methods

Prior to the experiment, the aerobic dance exercise program and fitball programs' validity were verified by three experts and reliability was verified by checking the heart rate of those who were within the criteria. The measurements of dependent variables were tested twice: before and after the experiments. The duration of the exercise program was 55 minutes per day, 3 days per week for continuous training of 12 weeks.

Before starting the exercise program, both low impact aerobic dance and fitball training group and low impact aerobic dance training group had taken the pre-test by using the research instruments. After taking the pre-test, they started the program. First step of practicing was warming up in both low impact aerobic dance and fitball training group and low impact aerobic dance training group. Both did the aerobic dance and stretched their muscles for 10 minutes. Following this,the low impact aerobic dance and fitball training group engaged in aerobic dance training for 20 minutes performing such as step touch, leg curl, knee up, easy walk and etc; exercised with fitball such as squat, pump ball, sit up, push up, shoulder flexion, side plank and pelvic thrust for 15 minutes. The low impact aerobic dance training group engaged in low impact aerobic dance training for 35 minutes. Both groups maintained at the intensity of 60-80% of maximum heart rate during exercise. Last step was cool down; the low impact aerobic dance and fitball training group stretched with fitball meanwhile the low impact aerobic dance training group stretched without fitball.

Data anaysis and Results

The statistical analysis was conducted by computer program. The data were analyzed by using the mean scores, standard deviation, percentage of change, paired t-test and independent samples t-test to test the statistical significance at the 0.05 level. There were 47 subjects completing the experiment divided into two groups: A) 23 in the low impact aerobic dance and fitball training group and B) 24 in the low impact aerobic dance training group.

After 12 weeks, the low impact aerobic dance and fitball training group decreased in β-CrossLaps significantly ($p<0.05$) when pre- and post tests were compared. The significant changes (β-CrossLaps 16.67% and 10.26% and P1NP 4.75% and 4.18%) between these two exercise groups were not found (Table 1 and Fig. 1, 2).

The physiological and fitness data shown in Table 2 indicated that the low impact aerobic dance and fitball training group and the other low impact aerobic dance training group had a significant decrease in resting heart rate, resting systolic and diastolic blood pressure and an increase in flexibility, muscular strength and endurance and maximum oxygen uptake when compared with pre- and post tests ($p<0.05$). However, flexibility was significantly different between the two groups ($p<0.05$) (Table 2).

Discusion

After the 12-week exercise training, statistically significant changes of bone resorption and bone formation (β-CrossLaps and P1NP) between the two exercise groups were not found ($p>0.05$). The two groups exercised the same intensity, frequency, duration, similar movements and weight bearing. According to Layne and Nelson, they concluded that weight bearing exercise is thought to provide the mechanical stimuli or "loading", important for the maintenance and improvement of bone health[6].

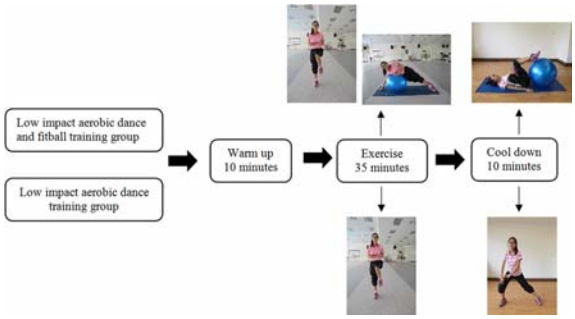


Fig. 1 Exercise.

Table 1. Bone formation and bone resorption data

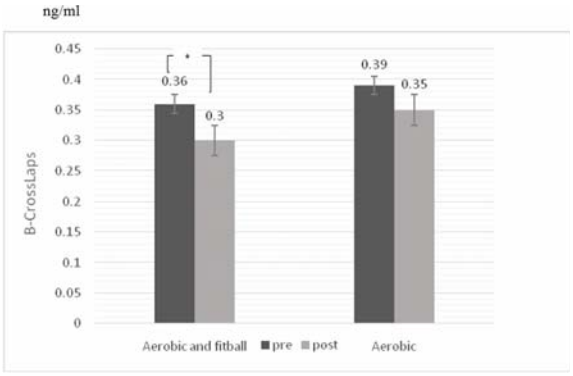
Variable	Low impact aerobic dance and fitball training (n = 23)			Low impact aerobic dance training (n = 24)		
	Pre-test $\bar{x} \pm$ SD	Post-test $\bar{x} \pm$ SD	% change	Pre-test $\bar{x} \pm$ SD	Post-test $\bar{x} \pm$ SD	% change
β-CrossLaps (ng/min)	0.36±0.13	0.30±0.15*	-16.67	0.39±0.22	0.35±0.19	-10.26
P1NP (ng/min)	41.01±14.36	42.96±15.03	+4.75	43.04±18.23	44.84±21.81	+4.18

* $p<0.05$ difference from the pre-test

Table 2. Physiological and health-related physical fitness data

Variables	Low impact aerobic dance and fitball training (n = 23)			Low impact aerobic dance training (n = 24)		
	Pre-test $\bar{x} \pm$ SD	Post-test $\bar{x} \pm$ SD	% change	Pre-test $\bar{x} \pm$ SD	Post-test $\bar{x} \pm$ SD	% change
Physiological						
Weight (kg)	59.38±2.73	58.91±2.76	0.79	58.82±6.30	57.89±4.97	1.58
BMI (kg/m^2)	24.08±1.76	23.67±2.01	1.57	24.27±3.63	23.60±1.35	2.76
Resting HR (b/m)	77.52±6.88	72.22±7.75*	6.84	78.00±5.59	70.92±2.99*	9.08
Resting SBP (mmHg)	119.22±14.37	111.04±9.36*	4.46	116.63±12.19	110.75±8.62*	5.04
Resting DBP (mmHg)	74.65±9.95	69.87±6.53*	6.40	77.04±6.45	67.08±6.28*	12.93
Health related fitness						
Flexibility (sit and reach, cm)	8.83±6.05	12.39±5.18*#	40.32	7.04±5.35	8.58±4.63	21.88
Muscular strength and endurance (chair sit to stand times/min)	43.83±8.42	49.65±9.12*	13.28	42.83±4.29	48.58±5.76*	13.43
VO_2 max (ml/kg/min)	31.55±5.75	37.47±6.92*	15.80	29.93±5.14	36.49±6.23*	17.98

* $p<0.05$ difference from the pre-test, # $p<0.05$ difference from the low impact aerobic dance training group



* $p<0.05$ difference from the pre-test

Fig. 2 β-CrossLaps pre and post exercise training.

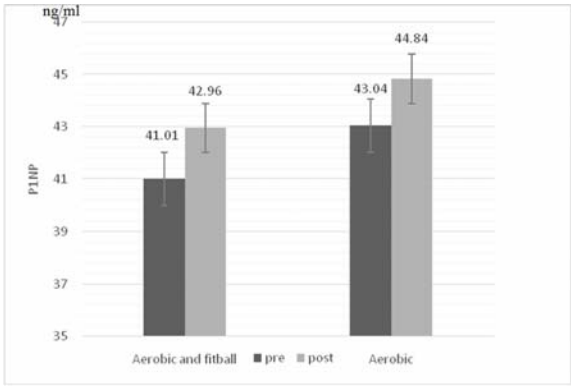


Fig. 3 P1NP pre and post exercise training.

Therefore, the effects of the low impact aerobic dance with or without fitball on β-CrossLaps and P1NP could not be determined. On the other hand, bone resorption (β-CrossLaps) of the low impact aerobic dance and fitball training group decreased after the complete experiment (Table 1). This can imply that weight-bearing with aerobic dance and fitball really affects bone resorption. The primary task of Swiss-ball, or fitball in resistance training, having greater force, is required for improving bone mass[6]. It was supported by the study of Namboolu, Bunyaratavej, and Kritpet[9], which found positive effects from mini-trampoline aerobic dance on bone resorption in working women.

These two exercise groups had a significant decrease in resting heart rate, systolic and diastolic pressure including increased in muscular strength and endurance, and maximum oxygen uptake after completing the 12-week program. However, lower back flexibility was significantly different between the groups. The results from different cross sectional studies of aerobic dance and fitness programs,

corresponding to ACSM recommendations indicated a positive stimulus for cardiorespiratory endurance and muscular fitness and flexibility[19] resting heart rate, muscular strength and flexibility[10], maximum oxygen uptake, and muscular strength in working women[18] and also lower back flexibility[16].

Conclusion

Therefore, the low impact aerobic dance and fitball training would provide a superior effect on bone resorption and lower back flexibility.

Acknowledgement

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Potential conflicts of interest

None.

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ผลของการฝึกเต้นแอโรบิกแบบแรงกระแทกต่ำและฟิตบอลต่อการสลายมวลกระดูกและสุขสมรรถนะในหญิงไทยวัยทำงาน

วณิชชา ฉัตรกุล ณ อยุธยา, ถนอมวงศ์ กฤษณ์เพ็ชร์

วัตถุประสงค์: *เพื่อศึกษาผลของการฝึกเต้นแอโรบิกแบบแรงกระแทกต่ำและฟิตบอลต่อการสลายมวลกระดูกและสุขสมรรถนะในหญิงไทยวัยทำงาน*

วัสดุและวิธีการ: *กลุ่มตัวอย่างเป็นอาสาสมัครหญิงวัยทำงานที่มีอายุระหว่าง 35-45 ปี เป็นบุคลากรจุฬาลงกรณ์มหาวิทยาลัยและบุคลากรกระทรวงสาธารณสุขจำนวน 47 คน ทำการเลือกกลุ่มตัวอย่างแบบเฉพาะเจาะจง และแบ่งกลุ่มตัวอย่างออกเป็น 2 กลุ่ม คือกลุ่มฝึกเต้นแอโรบิกแบบแรงกระแทกต่ำ (20 นาที) และฟิตบอล (15 นาที) จำนวน 23 คน และกลุ่มฝึกเต้นแอโรบิกแบบแรงกระแทกต่ำ (35 นาที) 24 คน โดยทำการฝึกพร้อมกับใส่เครื่องวัดอัตราการเต้นของหัวใจใช้ความหนักของการออกกำลังกายที่ 60-80% ของอัตราการเต้นหัวใจสูงสุดครั้งละ 35 นาที 3 ครั้ง/สัปดาห์ เป็นเวลา 12 สัปดาห์ ดำเนินการเก็บข้อมูลก่อนทดลองและหลังทดลอง โดยมีการทดสอบสารชีวเคมีของกระดูก (Biochemical bone marker) ข้อมูลทางสรีรวิทยาและสุขสมรรถนะแล้วนำผลที่ได้จากการทดลองทั้งก่อนและหลังการทดลอง 12 สัปดาห์ มาวิเคราะห์หาความแตกต่างภายในกลุ่มโดยทดสอบค่าทีแบบรายคู่ (Paired t-test) และเปรียบเทียบระหว่างกลุ่มด้วยการทดสอบค่าทีแบบอิสระ (Independent t-test) ที่ระดับความมีนัยสำคัญทางสถิติ 0.05*

ผลการศึกษา: *พบว่าทั้งกลุ่มฝึกเต้นแอโรบิกแบบแรงกระแทกต่ำและฟิตบอลและกลุ่มฝึกเต้นแอโรบิก แบบแรงกระแทกต่ำ มีค่าการสลายมวลกระดูก (β-CrossLaps) ลดลง ขณะที่กลุ่มแรกลดลงอย่างมีนัยสำคัญทางสถิติ ที่ระดับ 0.05 และพบว่าทั้งสองกลุ่มมีค่าของการสร้างมวลกระดูก (P1NP) และการสลายมวลกระดูก (β-CrossLaps) ไม่แตกต่างกันนอกจากนี้ทั้งกลุ่มฝึกเต้นแอโรบิกแบบแรงกระแทกต่ำและฟิตบอลและกลุ่มฝึกเต้นแอโรบิกแบบแรงกระแทกต่ำ ต่างมีค่าเฉลี่ยของอัตราการเต้นของหัวใจขณะพัก ความดันโลหิตขณะหัวใจบีบตัว ความดันโลหิตขณะหัวใจคลายตัวลดลงอย่างมีนัยสำคัญทางสถิติที่ระดับ 0.05 ด้านความอ่อนตัวและความแข็งแรงและความอดทนของกล้ามเนื้อขา และสมรรถภาพการใช้ออกซิเจนสูงสุดได้เพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติที่ระดับ 0.05 เมื่อเปรียบเทียบกับก่อนการทดลองแต่เมื่อเปรียบเทียบระหว่างกลุ่มไม่พบความแตกต่าง ยกเว้นด้านความอ่อนตัว*

สรุป: *การฝึกเต้นแอโรบิกแบบแรงกระแทกต่ำและฟิตบอลมีผลต่อการชะลอการสลายมวลกระดูกและเพิ่มความอ่อนตัวของหลังส่วนล่างได้ดี*