Effects of 9 months of whole body vibration in obese middle-aged women

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ABSTRACT

Health status has been improved by a reduction of body weight in obese individuals. However, in the process of losing body weight, changes of bone mineral density (BMD) should be considered at the same time, because body weight would be negatively correlated with the BMD. PURPOSE: This study was designed to investigate the effects of caloric restriction (CR), CR plus whole body vibration (WBV), CR plus aerobic exercise (AE), and CR plus combined exercise (CE) of WBV and AE on body composition and BMD. METHODS: Sixty obese middle-aged women volunteered to participate in the study and were divided into one of four intervention groups. Forty-five subjects [age: 41.2±0.9 yrs; percent body fat: 33.8 ±0.5 %] completed the study. Groups were CR only (n=9), CR + WBV (n=13), CR + AE (n=11), and CR + CE (n=12). Subjects in three training groups performed their assigned training for 33 minutes/day, 5days/week, and for 9 months. For a WBV session, subjects completed three 11-min sets of a rotation on the WBV platform that included four different body positions: standing (5 min), 2 types of a squat (2 min each) and one with greater upper body vibration (palms on the platform) (2 min). Intensity of WBV was determined by adjusting the frequency at an amplitude of 12.8 mm. Frequency was calculated by multiplying body weight by a constant that was previously determined to elicit a given VO_2. Intensity of aerobic exercise (treadmill and cycle ergometer on alternate days) was set at 75%HRmax, which was turned out to be equivalent to WBV intensity. Intensity was adjusted every 3 month. Each subject was asked to intake foods at the level of 70% of RDA throughout the intervention period for CR according to the guidance of a nutritional specialist. Body composition (fat weight, lean body weight, and %fat from DEXA, two skinfolds, and four circumferences) and BMD (DEXA) were measured before and at 3, 6, and 9 month of intervention. RESULTS: Body weight and %fat decreased more in training groups than CR ($P<0.05$). Whole body, lumbar spine, hip, and forearm BMD did not change significantly. CONCLUSION: CR plus WBV was as effective as CR plus aerobic exercise in improving body composition, and both exercises were more effective than CR alone. Even though body weight decreased more in CR+WBV and CR+AE than CR only, the training groups showed no negative effect on BMD.

INTRODUCTION

- A combination of diet [i.e., caloric restriction (CR)] and exercise is the most effective strategy for obesity. CR assists in weight loss, whereas exercise increases BMD while losing the body weight (Marcus et al., 1992).
- Despite the positive effects of regular exercise, exercise could have some detrimental effects such as damaged ligaments and lowered kidney function if performed incorrectly or excessively.
- Whole-body vibration (WBV) is used as an alternative exercise for unfit and older individuals
- Studies were conducted on changes in physical strength, BMD, and hormones resulting from WBV when used *in lieu* of other more conventional exercise.
- Flieger et al. (1998) reported positive effects of vibration on BMD in ovariectomized rats.
- Bosco et al. (2000) reported positive changes in testosterone and growth hormone in humans following WBV exercise.
- Studies comparing WBV with more conventional aerobic exercises are insufficient, especially regarding body composition and BMD.

PURPOSE

- This study was designed to examine the effects of 9 months of CR, CR plus WBV, CR plus AE, and CR plus CE on body composition and BMD in obese middle-aged women.

SUBJECTS

- Forty-five women [age: 41.2±0.9 yrs, %fat: 33.8 ±0.5 %]
- BMI over 35
- No participation in any exercise training for previous six months
- Randomly assigned to CR only (n=9), CR + WBV (n=13), CR + AE (n=11), and CR + CE (n=12).
- There were no significant differences in physical characteristics among the four groups in pre-test.

METHODS

- Body weight, body composition (fat weight, lean body weight, and %fat), and BMD (whole body, lumbar spine, hip, and forearm) were measured using DEXA before and at 3, 6, and 9 months of intervention.
- Each subject was asked to reduce food intake to 70% of their Recommended Dietary Allowance (RDA) throughout the intervention.
- Data regarding the food intake was collected by three-day (two weekdays and one weekend day) dietary log. Based on the log, daily caloric intake was calculated.
- Subjects' positions during WBV were shown in Figure 1.
- Subjects performed WBV exercise 3 sets, 11min per set, for a total of 33 min/session, 5 times per week, and for 9 months.
- Aerobic exercise was performed at 75% HRmax for 33 min and used cycle ergometer and treadmill walking on alternating days.
- Two-way ANOVA with repeated measured and LSD post hoc test were used for data analysis.
- Significance level was set at $P < 0.05$.

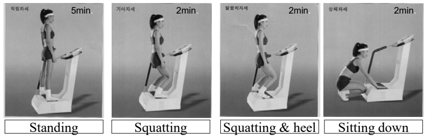

Figure 1. Various WBV training positions

RESULTS

- CR group showed higher total caloric intake than other groups at pre-test.
- From 3 months of intervention, all groups consumed approximately 70% of RDA (Table 1 & Figure 2).

Table 1. Changes of total caloric intake and % RDA before, during, and after four interventions

Variables	Groups	pre(Ⅰ)	3month(Ⅱ)	6month(Ⅲ)	9month(Ⅳ)
		M±SD	M±SD	M±SD	M±SD
Total calories (Kcal)	Diet (A)	1964.4±533.5 **B,D,Ⅱ,Ⅲ,Ⅳ**	1359.9±215.9	1337.9±328.2	1293.4±263.6
	Vibration(B)	1544.3±439.9	1374.0±226.3	1428.0±266.5	1358.3±287.7
	Aerobic(C)	1823.5±487.1	1470.9±192.7	1499.2±195.6	1582.5±271.5
	Combination(D)	1547.8±399.0	1351.2±110.8	1421.3±242.6	1414.8±284.8
%RDA calories (%)	Diet (A)	95.4±23.3 **Ⅱ,Ⅲ,Ⅳ**	68.0±10.8	67.5±16.7	65.2±12.4
	Vibration(B)	78.7±22.1	69.4±10.9	71.6±11.7	70.7±16.6
	Aerobic(C)	93.1±25.0 **Ⅱ,Ⅲ**	73.9±9.6	75.0±9.8	79.7±13.3
	Combination(D)	78.1±20.9	68.4±5.1	71.9±12.1	73.1±15.9

. A, B, C, D : significant difference among the groups
. Ⅰ, Ⅱ, Ⅲ, Ⅳ : significant difference among the tests in each group

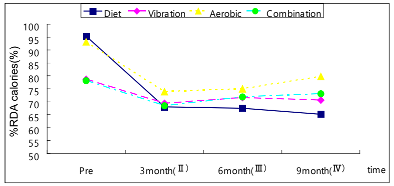

Figure 2. Changes of % RDA of caloric intake before, during, and after four interventions

- Body weight, body fat mass, and percent body fat of exercise groups decreased more significantly than CR (Table 2).
- After 6 months, changes in body weight and body composition were diminished and no significant difference were found among all groups.

Table 2. Changes of body composition before, during, and after four kinds of interventions

Variables	Groups	pre(Ⅰ)	3month(Ⅱ)	6month(Ⅲ)	9month(Ⅳ)
		M±SD	M±SD	M±SD	M±SD
Weight (kg)	Diet (A)	66.4±6.3 **Ⅱ,Ⅲ,Ⅳ**	64.0±6.1	62.9±5.1	63.0±6.0
	Vibration(B)	65.8±4.9 **Ⅱ,Ⅲ,Ⅳ**	62.8±4.7 **Ⅲ**	61.5±4.8	61.8±5.0
	Aerobic(C)	67.8±6.3 **Ⅱ,Ⅲ,Ⅳ**	64.0±5.7 **Ⅲ,Ⅳ**	61.9±5.7	61.6±5.4
	Combination(D)	65.3±5.4 **Ⅱ,Ⅲ,Ⅳ**	61.7±4.7 **Ⅲ,Ⅳ**	60.4±4.5 **Ⅳ**	59.2±4.4
Lean body mass (kg)	Diet (A)	42.5±4.4	41.7±4.2	41.7±3.2	41.3±3.7
	Vibration(B)	41.3±2.8 **Ⅱ,Ⅲ**	40.2±2.6	40.3±3.0	40.5±2.8
	Aerobic(C)	42.1±5.3	41.2±4.4	41.3±4.8	41.2±4.4
	Combination(D)	40.9±2.2 **Ⅱ**	40.0±2.0 **Ⅲ**	40.6±1.8	40.3±1.9
Body fat mass (kg)	Diet (A)	21.7±2.6 **Ⅱ,Ⅲ**	20.1±3.4 **Ⅲ**	18.9±3.2	19.5±3.9
	Vibration(B)	22.3±3.5 **Ⅱ,Ⅲ,Ⅳ**	20.5±3.5 **Ⅲ,Ⅳ**	19.0±3.0	19.1±3.6
	Aerobic(C)	23.5±2.0 **Ⅱ,Ⅲ,Ⅳ**	20.6±2.6 **Ⅲ,Ⅳ**	18.4±2.5	18.2±3.3
	Combination(D)	22.3±4.2 **Ⅱ,Ⅲ,Ⅳ**	19.5±3.3 **Ⅲ,Ⅳ**	17.5±3.6 **Ⅳ**	16.8±3.3
Body fat (%)	Diet (A)	32.6±2.4 **Ⅱ,Ⅲ**	31.3±3.6	30.0±3.5	30.7±4.0
	Vibration(B)	33.8±3.5 **Ⅱ,Ⅲ,Ⅳ**	32.4±3.7 **Ⅲ,Ⅳ**	30.8±3.4	30.8±4.1
	Aerobic(C)	34.5±2.5 **Ⅱ,Ⅲ,Ⅳ**	32.2±3.3 **Ⅲ,Ⅳ**	29.7±3.8	29.5±4.7
	Combination(D)	33.9±3.8 **Ⅱ,Ⅲ,Ⅳ**	31.5±3.0 **Ⅲ,Ⅳ**	28.8±3.8	28.2±3.5

. Ⅰ, Ⅱ, Ⅲ, Ⅳ : significant difference among the tests in each group

- There were significant interactions between group and test in percent body fat (Figure 3) and body fat mass.

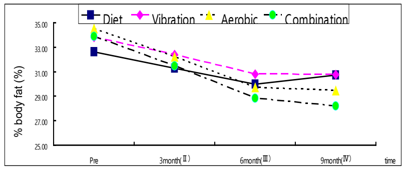

Figure 3. Changes of percent body fat before, during, and after four interventions

SUMMARY & CONCLUSION

- Body weight, body fat mass, and percent body fat significantly decreased in all groups, and the trend was more significant in exercise groups than the diet group. There was no significant difference in the variables between whole body vibration exercise group and aerobic exercise group.
- Bone mineral density of whole body, lumbar spine, hip, and forearm did not show significant differences among four groups at each test.
- It was concluded that whole body vibration as well as aerobic exercise training performed over a long period had positive effects on body composition and BMD in obese middle-aged women.

REFERENCE

- Marcus, R., Drinkwater, B., Dalsky, G., Dufek, J., Raab, D., Slemenda, C., & Snow-Harter, C.(1992). Osteoporosis and exercise in women. Med. Sci. Sports Exerc., 24(6): 301-307.
- Flieger, J., Karachalios, T., Khaldi, L., Raptou, P., & Lyritis, G.(1998). Mechanical stimulation in the form of vibration prevents post menopausal bone loss in ovariectomized rats. Calcif. Tissue Int., 63: 510-514.
- Bosco, C., Iacovelli, M., Tsarpela, O., Cardinale, M., Bonifazi, M., Tihanyi, J. Viru, M., De Lorenzo, A., & Viru, A.(2000). Hormonal responses to whole-body vibration in men. Eur. J. Appl. Physiol., 81: 449-454.