

# The effects of trunk stabilization exercise on bone density after menopause

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**Abstract.** [Purpose] This study examined the effect of low intensity exercise on bone density by conducting trunk stabilization exercise on females after menopause for 24 weeks. [Subjects and Methods] Thirty three female subjects over 47 years old and under the age of 53 were selected and 16 for experimental group and 17 for control group were randomly selected. Experimental group had performed spinal and pelvic stabilization exercise 30 minutes a day, 5 times a week, for 24 weeks. Except for the daily life, control group did not participate in any characteristic movement. Bone density of every member in experimental group was measured using average value of bone density of 1st–4th lumbar through quantitative computer tomography. [Results] There was a meaningful difference in only control group about measured value of bone density within each group, experimental and control group, but there was no meaningful difference in measured value of bone density between two groups, experimental group and control group. [Conclusion] Through this research, we could see the fact that although trunk stability exercise could not change bone density meaningfully, it could maintain bone density. In the future, it is randomly necessary to study things related this because results of researches can show different results according to exercise intensity, exercise period, age, weight, hormone status and mediation period. It is considered that it will help to prevent and treat patients with osteoporosis a lot.

**Key words:** Bone mineral density, Computer tomography, Low intensity exercise

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## INTRODUCTION

Menopause appearing in a normal time is a state of amenorrhoea for 12 months continuously without removing uterus or ovary surgically, injecting hormone and lack dietary<sup>1)</sup>. It has been reported that incidence of cardiovascular disease and osteoporosis increase in postmenopausal women and overall body composition are being changed negatively such as muscle weakness<sup>2, 3)</sup>. Especially, osteoporosis is metabolic disease of bone and it occurs when bony tissue per unit volume decreases and bone resorption rate increases<sup>4)</sup>. Fracture can occur easily by a minor shock through change of bone density. So it lowers the quality of life<sup>5, 6)</sup>. Today, patients with osteoporosis are increasing steadily because our country is aging society. But until now there is no sure method of treatment<sup>7)</sup>. So, early diagnosis and prevention are emphasized more. Medicine treatment is used in prevention and treatment of osteoporosis. But many researches regarding exercise program which is a drug free solution are being carried due to side effect and burden of expense

about medicine. And proper exercise program is considered as essential element to increase bone density, treat and prevent osteoporosis<sup>8, 9)</sup>. Jeong et al.<sup>10)</sup> said that postmenopausal women who received weight training for 48 weeks had a positive effect in terms of increase of bone density, isokinetic muscular strength and body composition. Also, Yoo et al.<sup>9)</sup> performed weight bearing exercise and muscle strengthening exercise. Meta analysis investigating effect on bone density of women in after middle age showed that weight bearing exercise worked best and muscle strengthening exercise didn't have a across-the-board result. On the other hand, Bocalini et al.<sup>11)</sup> performed muscle strengthening exercise targeting 25 menopausal women for 24 weeks. And they measured bone density of before and after muscle strengthening exercise. There was meaningful difference in group for resistance movement. Especially, moderate resistance movement could inhibit bone loss of menopausal women and could inhibit loss of bone density of a femur and lumbar spine bone. This study is a contrast to Rittweger's<sup>12)</sup> research that low intensity of exercise can't increase bone density. It is considered that opinions about change of bone density are unsound. But it is necessary to study effect of exercise related to bone density systematically due to various advantages of exercise treatments which have been used and recommended frequently in clinical. There are Dual Photon Absorptiometry, Single Photon Absorptiometry, Dual energy x-ray Absorptiometry, Quantitative Computed Tomography in methods to examine bone density for sys-

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tematic research. Quantitative Computed Tomography is measured by separating cancellous bone from cortical bone and it is so accurate because of obtaining three dimensional pure bone density without overlapping with other tissue<sup>13)</sup>. Whereas many researches about effect of exercise on bone density have been done, they are controversial in terms of effect, intensity and period of exercise.

This research intends to contribute to preventing and treating osteoporosis for postmenopausal women by finding effect of low intensity exercise on bone density through performing spinal and pelvic stabilization exercise for 24 weeks and providing preliminary clinical data.

## SUBJECTS AND METHODS

This study was approved by bioethics Committee of Sehan university center (IRB) (Approval number: 2014-10) on October 1, 2014. It had been done targeting 33 subjects taking checkups over 47 years old and under the age of 53 in a medical institution located in Jeollanamdo, South Korea between 1 November, 2014 and 30 July, 2015 for 9 months. Subjects had not regularly exercised for 6 months and had not received hormone injection and medical treatment for osteoporosis and women who have had a state of menopause for more than a year or under 2 years without special lesion were selected and intervened for 24 weeks and they understood purpose of this study very well and agreed to participate in this study voluntarily. There were 17 women for control group and 16 women for experimental group among total 33 women. Distribution of age was 51.5 years old in control group and 50.3 years old in experimental group. Height was 160.8 cm in control group and 159.9 cm in experimental group. Distribution of weight was 62.7 kg in control group and 63.6 kg in experimental group. And distribution of bone density was 62.04 mg/cc in control group and 63.64 mg/cc in experimental group. There was no research variable appearing a meaningful difference in all general characteristics between control group and experimental group. So, it showed that two groups were the same. Table 1 shows the characteristic of subjects. 17 women for control group and 16 women for experimental group were randomly selected among 33 women after menopause. Experimental

group had performed spinal and pelvic stabilization exercise 30 minutes a day, 5 times a week, for 24 weeks. Except for the daily life, control group did not participate in any characteristic movement. Height and weight of all subjects were tested using JENIX before performing experiment. Bone density was tested using High Speed-NX/I (General electric. Japan) and Quantitative Computed Tomography before and after experiment and BMC (Bone Mineral Contents) was tested using mean value of bone density of lumbar 1st and 4th. Trunk stability exercise used by Lee et al.<sup>14)</sup> was used as spinal and pelvic stabilization exercise. It is composed of step1 (awareness stage), step 2 (associative stage), and step 3 (exercise task stage) according to basis of research of O'Sullivan. Exercise method had been done 30 minutes a session; 5 times a week, for 24 weeks and it was applied to subjects considering their exercise ability (Table 2).

SPSS 17.0 for window was used as data processing method and Independent t-test was used to compare homogeneity between groups about general characteristics and bone mineral contents. Paired t-test was used to compare before and after result within group and ANCOVA was used to analyze change between experimental group and control group. Significance level was set as  $\alpha=0.05$ .

## RESULTS

1) There was no meaningful difference in change of bone density within experimental group which had 63.64 mg/cc before doing experiment and 66.9 mg/cc after doing experi-

**Table 1.** Characteristic of subjects

	Control group (n=17)	Experimental group (n=16)
Age (years)	51.5±3.5 <sup>a</sup>	50.3±4.6
Height (cm)	160.8±5.1	159.9±5.0
Weight (kg)	62.7±6.6	63.6±6.6
BMC (mg/cc)	62.0±9.5	63.6±5.1

<sup>a</sup>Mean± SD

Control group: non exercise group, Experimental group: trunk stabilization exercise group

**Table 2.** Program of trunk muscle stabilization

Trunk muscle stabilization intervention exercise program			
Stage	Time	Contents	Program
Warming-up exercise	5 min	Flexibility whole body exercise	Upper-lower extremity stretching and joint moving exercise
Main exercise	20 min	Trunk muscle stabilization exercise	Stage 1
			Stage 2
			Stage 3
Cooling-down exercise	5 min	Breathing and aerobic exercise	Breathing with abdominalis

- 1) Pelvic posterior tilting on supine position with both knee flexion
- 2) Abdominal draw-in on supine position with both knee flexion
- 3) Pelvic anterior tilting on supine position with both knee extension
- 4) Abdominal draw-in on supine position with both knee extension
- 5) Bridging in supine position
- 6) Ball bridge
- 7) Unstable bridging : bridging with extension of left/right leg

ment. But there was a meaningful difference in change of bone density of control group which had 62.04 mg/cc before doing experiment and 60.03 mg/cc after doing experiment ( $p < 0.05$ ) (Table 3).

2) There was no meaningful difference in change of bone density between experimental group which had 63.64 mg/cc before doing experiment and 66.9 mg/cc after doing experiment and control group which had 62.04 mg/cc before doing experiment and 60.03 mg/cc after doing experiment (Table 4).

## DISCUSSION

Osteoporosis is classified as two types. Type I is osteoporosis after menopause and type II is senile osteoporosis. Osteoporosis after menopause which is type I causes compression fracture of spine and distal radius fracture by decrease of spongy bone. And it often occurs between 50 and 60 years old<sup>15</sup>. It is said that osteoporosis after menopause is developed by losing the balance of osteoclasts and osteogenesis due to increase of osteoclasts by osteoclast through decrease of estrogen secretion<sup>4, 16</sup>. Also, decrease of bone density is quickly progressing within three years after menopause and average loss rate of bone density reaches 9 percent a decade while aging is progressing in late forties<sup>17</sup>. Elements of exoskeleton and endoskeleton should be considered to maintain bone density and prevent decrease of bone density. Body activities, exercise, hormone and nutrition and so on are included in elements of exoskeleton and endoskeleton. Especially, exercise should be surely considered for comprehensive management because it is not sufficient for medicine treatment to decrease rate of bone loss<sup>18, 19</sup>.

Spinal and pelvic stabilization exercise which is low intensity exercise had been performed to women after menopause for 24 weeks in this study and this study investigated effect of low intensity exercise on bone density and found that there was no a meaningful difference in change of bone density within experimental group which had 63.64 mg/cc before doing experiment and had 66.9 mg/cc after doing experiment. But there was a meaningful difference in change of bone density within control group which had 62.04 mg/

cc before doing experiment and had 60.03 mg/cc after doing experiment ( $p < 0.05$ ). And there was no meaningful difference statistically in change of bone density between two groups. Bone density of experiment group was 63.64 mg/cc before doing experiment and 66.9 mg/cc after doing experiment. Bone density of control group was 62.04 mg/cc before doing experiment and 60.03 mg/cc after doing experiment.

Spinal and pelvic stabilization exercise failed to improve bone density but it could maintain bone density when compared to control group. Lee<sup>20</sup> researched how training of t'ai chi chuan affects bone density and bone marker of women after menopause for 12 weeks. As a result, training of t'ai chi chuan for 12 weeks failed to increase bone density but it decreased rates of bone loss. Also, Han<sup>14</sup> performed resistance exercise program targeting 11 women after menopause for 6 weeks and measured bone density of lumbar and femur. There was not a meaningful difference statistically in this result but bone density of lumbar increased. It implies that we can see the change of bone density by doing exercise for a short time and especially, this study receives support in the way that exercises that don't have a high intensity such as t'ai chi chuan can affect rates of bone loss.

Also, Sinaki<sup>18</sup> said that if safety and Peripheral muscle strengthening through load of direction of major axis of spine work basically, it can help to prevent falling and spinal fracture of women with osteoporosis. On the other hand, Wolf's<sup>21</sup> meta-analysis showed that exercise should have a high intensity to have the change of bone density. Also, Kelley's<sup>22</sup> meta-analysis showed that exercise of low intensity can't make change of bone density. But, recently meta analysis performed by Tanaka et al.<sup>21</sup> made an interesting offer that Asian don't need to do exercise of high intensity than Westerner. They claimed that Asian has lower BMI than Westerner. And because persons who have a slender frame (<57.8 kg) or women have a small bone mass from the beginning, exercise of low intensity can affect bone density of persons who have a small frame as Asian<sup>24</sup>. This hypothesis supports this study.

T'ai chi chuan mentioned earlier is a low intensity exercise which has advantages that it does not use tools and it is not limited by place<sup>25</sup>. Also, spinal and pelvic stabilization

**Table 3.** Comparison BMC on control group and experimental group

Categories	Pre-test	Post-test
Control group (n=17)	62.0±9.5 <sup>a</sup>	60.0±11.6
Experimental group (n=16)	63.6±5.1	66.9±5.0

\* $p < 0.05$

<sup>a</sup>Mean± SD, Paired t-test

Control Group: non exercise group, Experimental group: trunk stabilization exercise group

**Table 4.** Comparison BMC between control group and experimental group

Categories	Pre-test	Post-test
Control group (n=17)	62.0±9.5 <sup>a</sup>	60.0±11.6
Experimental group (n=16)	63.6±5.1	66.9±5.0

<sup>a</sup>Mean± SD, ANCOVA

Control group: non exercise group, Experimental group: trunk stabilization exercise group

exercise used in this study is a low intensity exercise which has advantages that it doesn't use tools and it can be performed at home or everywhere in indoor. We expect that it can prevent osteoporosis occurred after menopause and can be a good way to reduce loss in terms of social economy<sup>18</sup>. But many researches are showing different results about exercise intensity and exercise period. We can guess that many researches can have different results because taking calcium agent, injecting hormone and daily life were not controlled properly<sup>9</sup>. But most researches have a common opinion that proper exercise has a positive effect on prevention and treatment of osteoporosis<sup>23</sup>. Also, this study did not control taking calcium agent, daily life, and starting point of menopause of subjects exactly. But through this research, we can see the fact that although trunk stability exercise cannot change bone density meaningfully, it can maintain bone density. In the future, it is randomly necessary to study things related this because results of researches can show different results according to exercise intensity, exercise period, age, weight, hormone status and mediation period. It is considered that it will help to prevent and treat patients with osteoporosis a lot.

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#### REFERENCES

- 1) Francucci CM, Romagnì P, Camilletti A, et al.: Effect of natural early menopause on bone mineral density. *Maturitas*, 2008, 59: 323–328. [[Medline](#)] [[CrossRef](#)]
- 2) Uddenfeldt M, Janson C, Lampa E, et al.: High BMI is related to higher incidence of asthma, while a fish and fruit diet is related to a lower—results from a long-term follow-up study of three age groups in Sweden. *Respir Med*, 2010, 104: 972–980. [[Medline](#)] [[CrossRef](#)]
- 3) Cho JH, Kim MT, Lee HK, et al.: Factor analysis of biochemical markers associated with bone mineral density in adults. *J Phys Ther Sci*, 2014, 26: 1225–1229. [[Medline](#)] [[CrossRef](#)]
- 4) Kim CK, Jung DI: The change of bone mineral density and bone strength by aquatic exercise and drynariae rhizoma on the osteoporosis-induced rats. *J KoCon*, 2009, 9: 218–226.
- 5) Adachi JD, Adami S, Gehlbach S, et al. GLOW Investigators: Impact of prevalent fractures on quality of life: baseline results from the global longitudinal study of osteoporosis in women. *Mayo Clin Proc*, 2010, 85: 806–813. [[Medline](#)] [[CrossRef](#)]
- 6) Bolton KL, Egerton T, Wark J, et al.: Effects of exercise on bone density and falls risk factors in post-menopausal women with osteopenia: a randomised controlled trial. *J Sci Med Sport*, 2012, 15: 102–109. [[Medline](#)] [[CrossRef](#)]
- 7) Shin HK, Cho KH: Association between physical performance and bone mineral density in elderly women. *J Kor Soc Phys Ther*, 2009, 21: 37–42.
- 8) Kelley GA, Kelley KS, Tran ZV: Resistance training and bone mineral density in women: a meta-analysis of controlled trials. *Am J Phys Med Rehabil*, 2001, 80: 65–77. [[Medline](#)] [[CrossRef](#)]
- 9) Yoo JS, Park JW, Lee SJ: A meta analysis on the effects of exercise on bone mineral density among middle-aged and older women. *J Korean Acad Community Health Nurs*, 2009, 20: 285–295.
- 10) Joeng YM, Lee YD, Oh KM: The effect of long-term weight training on bone density, isokinetic muscular strength and body composition of post-menopausal women. *JCD*, 2010, 12: 132–142.
- 11) Bocalini DS, Serra AJ, Dos Santos L: Moderate resistive training maintains bone mineral density and improves functional fitness in postmenopausal women. *J Aging Res*, 2010, 2010: 760818. [[CrossRef](#)] [[Medline](#)]
- 12) Rittweger J: Can exercise prevent osteoporosis? *J Musculoskeletal Neuronal Interact*, 2006, 6: 162–166. [[Medline](#)]
- 13) Yeo JD, Park JS: A study on spinal bone mineral density measured with quantitative computed tomography. *KJOHSM*, 2009, 3: 87–94.
- 14) Lee JY, Park JS, Lee DH, et al.: Effect of the trunk muscle stabilization training on balance for chronic stroke patients. *JKAIS*, 2012, 13: 1212–1219.
- 15) Han JK: The effect of progressive resistance exercise on osteocalcin or bone density in postmenopausal women. *KSSS*, 2008, 17: 571–578.
- 16) Eastell R, Delmas PD, Hodgson SF, et al.: Bone formation rate in older normal women: concurrent assessment with bone histomorphometry, calcium kinetics, and biochemical markers. *J Clin Endocrinol Metab*, 1988, 67: 741–748. [[Medline](#)] [[CrossRef](#)]
- 17) Gardner FH, Gallagher MT, Datta SK, et al.: The abrogation of in vivo resistance to parental bone marrow transplantation and of in vitro natural cell-mediated cytotoxicity to the YAC lymphoma by in vivo growth of a transformed thymus-derived cell culture. *Exp Hematol*, 1980, 8: 1040–1047. [[Medline](#)]
- 18) Sinaki M: Exercise for patients with osteoporosis: management of vertebral compression fractures and trunk strengthening for fall prevention. *PM R*, 2012, 4: 882–888. [[Medline](#)] [[CrossRef](#)]
- 19) Korkmaz N, Tutoğlu A, Korkmaz I, et al.: The relationships among vitamin D level, balance, muscle strength, and quality of life in postmenopausal patients with osteoporosis. *J Phys Ther Sci*, 2014, 26: 1521–1526. [[Medline](#)] [[CrossRef](#)]
- 20) Lee EN: Effects of a 12-week tai chi on the bone mineral density and bone metabolic markers in postmenopausal women. *J Muscle Joint Health*, 2011, 18: 73–82. [[CrossRef](#)]
- 21) Wolff I, van Croonenborg JJ, Kemper HC, et al.: The effect of exercise training programs on bone mass: a meta-analysis of published controlled trials in pre- and postmenopausal women. *Osteoporos Int*, 1999, 9: 1–12. [[Medline](#)] [[CrossRef](#)]
- 22) Kelley GA: Exercise and regional bone mineral density in postmenopausal women: a meta-analytic review of randomized trials. *Am J Phys Med Rehabil*, 1998, 77: 76–87. [[Medline](#)] [[CrossRef](#)]
- 23) Tanaka R, Ozawa J, Umehara T, et al.: Exercise intervention to improve the bone mineral density and bone metabolic markers as risk factors for fracture in Japanese subjects with osteoporosis: a systematic review and meta-analysis of randomized controlled trials. *J Phys Ther Sci*, 2012, 24: 1349–1353. [[CrossRef](#)]
- 24) National Osteoporosis Foundation: *Osteoporos Int*, 1998, 7: 7–80.
- 25) Wayne PM, Kiel DP, Krebs DE, et al.: The effects of Tai Chi on bone mineral density in postmenopausal women: a systematic review. *Arch Phys Med Rehabil*, 2007, 88: 673–680. [[Medline](#)] [[CrossRef](#)]