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Physical activity and bone mineral density in postmenopausal women without estrogen deficiency in menstrual history

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ABSTRACT

Introduction: The estrogen deficiency after menopause leads to accelerated loss of bone mass. The aim of this study was to examine influence of physical activity on bone mineral density in postmenopausal women who hadn't a deficit of estrogen in their menstrual history.

Methods: This prospective study included 100 postmenopausal women, ages between 50 and 65, living in Sarajevo area without estrogen deficiency in menstrual history. The women in the examination group had osteoporosis. The women in the control group had osteopenia or normal mineral bone density. Mineral bone density was measured at the lumbar spine and proximal femur by Dual–Energy X–ray Absorptiometry using Hologic QDR-4000 scanner. To assess level of physical activity an International Physical Activity Questionnaire - Long Form was used.

Results: In the examination group of women who had no history of menstrual estrogen deficit, level of physical activity was low in 52.00% female, and in 48.00% women level of physical activity was moderate. In the control group of women who had no history of menstrual estrogen deficit in 10.00% female level of physical activity was low, and in 90.00% female level of physical activity was moderate. The difference in levels of physical activity between the two groups was statistically significant, X_2 test = 20.6, p <0.005.

Conclusion: Results of this study suggest that moderate physical activity has positive impact on bone mineral density in postmenopausal women without estrogen deficiency in menstrual history and has the potential to reduce rapid bone loss after menopause.

Keywords: osteoporosis, physical activity.

INTRODUCTION

Osteoporosis is characterized by low bone mass which may be the consequence of development of the skeleton during adolescence (low „peak" bone mass) and/or exessive bone loss thereafter (1). Sex hormones are crucial for keeping bone mass in balance, and the lack of either estrogen or testosterone leads to decreased bone mass and increased risk for osteoporosis (2). After menopause phase of accelerated bone degradation occurs and lasts 4-8 years, initiated by dramatic reduction in estrogen production by the ovaries (3, 4).

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Both estrogen and androgens inhibit bone resorption via effects on the receptor activator of NF-kappaB ligand RANKL/RANK/osteoprotegerin system, as well as by reducing the production of a number of pro-resorptive cytokines, along with direct effects on osteoclast activity and lifespan (5). Estrogens and androgens also exert effects on the lifespan of mature bone cells: pro-apoptotic effects on osteoclasts but anti-apoptotic effects on osteoblasts and osteocytes (6). Sex steroid effects on bone formation are also likely mediated by multiple mechanisms, including a prolongation of osteoblast lifespan via non-genotropic mechanisms, as well as effects on osteoblast differentiation and function (5). Estrogen is known to have a variety of effects on the proliferation and synthesis of enzymes and bone matrix proteins by osteoblast – like cells through a process mediated by complex biomolecular biologic signals and mechanisms (7).

The activities of osteoblasts and osteoclasts are controlled by a variety of hormones and cytokines, as well as by mechanical loading (2).

Biochemical and molecular biological studies have resulted in the identification of the gene of which expression level is changed by mechanical stress (8). Bone tissue has a mechanosensing apparatus that directs osteogenesis to where it is most needed to increase bone strength and the most likely sensors of mechanical loading are the osteocytes, which are visco-elastically coupled to the bone matrix so that their biological response increases with loading rate; thus, increasing loading frequency improves the responsiveness of bone to loading (9).

Research shows that physical activity modifies level of various hormones involved in bone metabolism, including gonadal sex hormone levels and calciotropic hormone levels (10, 11, 12). The reproductive abnormalities observed in female athletes generally originate in hypothalamic dysfunction and disturbance of the gonadotropin-releasing hormone (GnRH) pulse generator, although specific mechanisms triggering reproductive dysfunction may vary across athletic disciplines, the clinical consequences associated with suppression of GnRH include infertility and compromised bone density, which appears to be irreversible (13).

The aim of this study was to examine influence of physical activity on bone mineral density in postmenopausal women without estrogen deficiency in their menstrual history (no late menarche, no premature menopause).

METHODS

This prospective study included 100 postmenopausal women living in Sarajevo area (Sarajevo Canton) without estrogen deficiency in menstrual history (normal menstrual history).

Mineral bone density was measured at the lumbar spine and proximal femur by Dual–Energy X–ray Absorptiometry using Hologic QDR-4000 scanner.

Examination group included 50 postmenopausal women, ages between 50 and 65, with osteoporosis (a value of BMD 2.5 standard deviations or more below the young adult mean)

Control group included 50 postmenopausal women, ages between 50 and 65, with osteopenia

(a value of BMD more than 1 standard deviations below the young adult mean, but less than 2.5 standard deviations below this value) or normal bone mineral density (a value of BMD within 1 standard deviation of the young adult reference mean)

The women in the both group had normal menstrual history, without estrogen deficiency in

menstrual history (no late menarche, no premature menopause).

The inclusion criteria were: women aged 50-65 years, women who live in the Sarajevo Canton, postmenopausal women without estrogen deficiency in menstrual history (no late menarche, no premature menopause), women who do not use hormone replacement therapy, women whose finding's of bone densitometry (DEXA) was at the level of osteoporosis, women whose finding's of bone densitometry (DEXA) was at the level of osteopenia or normal. The exclusion criteria were: women younger than 50 and older than 65 years, women who do not live in the Sarajevo Canton, postmenopausal women with estrogen deficiency in menstrual history (late menarche, premature menopause), women who are not postmenopausal, women who use hormone replacement therapy, women who have a disease that can cause osteoporosis, women who use medicines that may cause osteoporosis.

To assess level of physical activity an International Physical Activity Questionnaire - Long Form (IPAQ – Long Form), was used. Physical activity was assessed in the four domains: work-related physical activity, transport-related physical activity, domestic and gardening (yard) activities and leisure time physical activity, in the last 7 days. There are three levels of physical activity (categorical score): low physical activity, moderate physical activity and high physical activity. Mentioned are only those activities which were carried out for at least 10 minutes.

Statistical analysis

Statistical significance between examination and control group in physical activity level was tested by Chi square test. $P < 0.05$ was considered statistically significant.

RESULTS

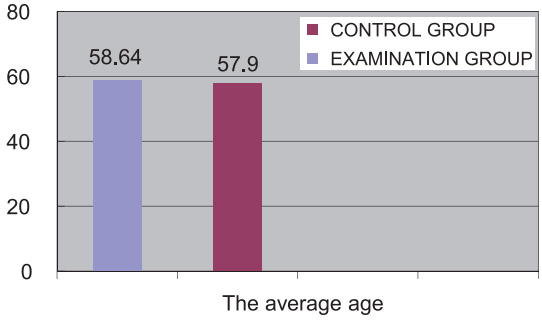

FIGURE 1. The average age of women without estrogen deficiency in menstrual history
t = 0.746, no statistically significant

TABLE 1. Level of physical activity of women without estrogen deficiency and statistical significance of difference in the level of physical activity between examination and control group

Level of physical activity	Examination group		Control group		Hi square test, Significance level
	n	%	n	%	
Low	26	52.00	5	10.00	
Moderate	24	48.00	45	90.00	χ^2 test =20.6 p < 0.005
Total number of women	50	100.00	50	100.00	

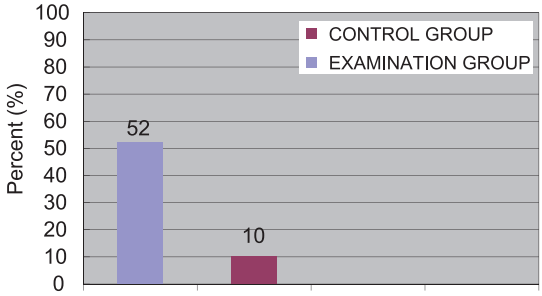

FIGURE 2. Level of physical activity of women without estrogen deficiency (low physical activity)

The average age of women without estrogen deficiency in their menstrual history in the examination group was 58.64 years, and in the control group was 57.9 years. There was no statistically significant differences between these two groups, t = 0.746.

In the examination group of women who had no history of menstrual estrogen deficit, level of physical activity was low in 26 (52.00%) female, and in 24 (48%) women level of physical activity was moderate. In the control group of women who had no history of menstrual estrogen deficit in 5 (10.00%) female level of physical activity was low, and in 45 (90.00%) female level of physical activity was moderate. The difference in levels of physical activity between the two groups was statistically significant, X^2 test = 20.6, p <0.005.

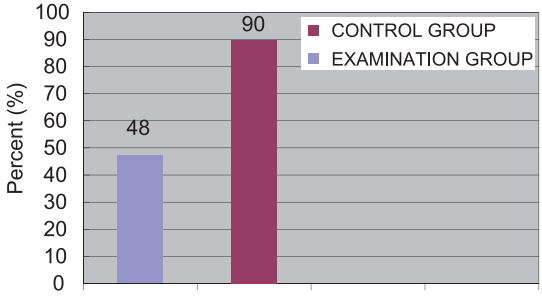

FIGURE 3. Level of physical activity of women without estrogen deficiency (moderate physical activity)

DISCUSSION

Among the estrogen target organs, bone has recently drawn increasing attention because postmenopausal

osteoporosis induced by estrogen deficiency has emerged as the most widely spread bone/joint disease in developed countries (14). Loss of estrogen leads to increased rate of remodeling and tilts the balance between bone resorption and formation in favor of the former (6). Post-menopausal osteoporosis is characterized by increased fracture risk due to deficiencies in both the quantity and quality of bone (15). The aim of this study was to examine influence of physical activity on bone mineral density in postmenopausal women who hadn't a deficit of estrogen in their menstrual history (no late menarche, no premature menopause). The mechanisms through which physical activity affects the bone tissue are incompletely understood, and some results of research are contradictory (16). Model of the osteogenic potential of exercise has not been established in humans (17). Research suggest that the frequency, intensity, time and type of physical activity, is directly related to its effects on bone tissue.

In the study of Bonaiuti D et al. showed that aerobics, weight bearing and resistance exercises are all effective in increasing the BMD of the spine in postmenopausal women, and walking is also effective on the hip (18). Hagberg JM. et al. find that prolonged low-to-moderate-intensity physical activity, but not the same number of years of higher-intensity training for competitive events, was independently associated with higher BMD (19). The results of the study of Feskanich D. et al. showed that moderate levels of activity, including walking, are associated with substantially lower risk of hip fracture in postmenopausal women (20). Schmitt et al. find that physical activity effectively slows bone loss in postmenopausal women in a dose-dependent manner and that in order to maximize the goals of public health most effective, individually adapted, intense, high impact exercise programs are needed (21). As indicated in the Ryan et all. study, 6-month of whole-body resistive training increases muscle mass and improves BMD of the femoral region in young and healthy older men and women as a group, with a trend for this to be greater in young subjects (22). Roghani T. et al. evaluated the effect of submaximal aerobic exercise with and without external loading on bone metabolism and balance in postmenopausal women with osteoporosis. Results showed that the two exercise programs (aerobic, weighted vest) stimulate bone synthesis and decrease bone resorption in postmenopausal women with osteoporosis (23). Although the study of Kemmler W et al. marginally failed to determine significant effects on overall fracture risk or rate ratio, the study increased the body of evidence for the fracture prevention efficiency of exercise programs, with special regard on bone strength (as assessed by bone mineral density measurement) (24).

Ethnic differences in absolute fracture risk may warrant ethnic-specific clinical recommendations (25). There is a large variation in hip fracture incidence from different regions of the world (26). Bone loss subsequently occurs with ageing in both sexes, and in females accelerated loss occurs at the menopause (27). Due to these variations it is necessary that research be carried out within certain population groups. In this study, investigated was the influence of physical activity on bone mineral density in postmenopausal women, aged 50-65 years, who live in the area of Sarajevo Canton, who did not have a deficit of estrogen in their menstrual history (no late menarche, no premature menopause).

Physical activity in daily life was examined in the four domains: work-related physical activity, transport-related physical activity, domestic and gardening (yard) activities and leisure time physical activity. There were three levels of physical activity (categorical score): low physical activity, moderate physical activity and high physical activity. It was shown that moderate intensity physical activity, performed during daily life, positively affects bone mineral density. Based on the results of the research, physical activity of moderate intensity is recommended in the course of daily life, in order to maintain and improve bone health in postmenopausal women (menstrual history without estrogen deficiency), aged 50-65 years, who live in the area of Sarajevo Canton.

CONCLUSION

Results of this study suggest that moderate physical activity has positive impact on bone mineral density in postmenopausal women (without estrogen deficiency in menstrual history) and has the potential to reduce rapid bone loss associated with decrease in estrogen at the time of menopause.

COMPETING INTERESTS

The authors declare no conflict of interest

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