Influence of physical activity in childhood on bone state, physical capabilities of postmenopausal women with osteoporosis and vertebral fractures

Abstract. Background. To date, the results of scientific research continue to discuss the long-term effect of regular sports in childhood on the prevention of bone quality loss in postmenopausal women, as well as the positive effect of a sufficient level of physical activity in the prevention of osteoporotic fractures in women older age. The purpose was to assess the effect of physical activity (PA) in childhood on the state of BT, physical capabilities of postmenopausal women with osteoporosis and vertebral fractures. Materials and methods. As part of a single-stage study, 115 postmenopausal women aged 50–89 years were examined. For the analysis, the selected individuals were divided into groups: I (control) group — women without any history of osteoporotic fractures (n = 84), II (main) group — patients with vertebral fractures at the level of the thoracic and lumbar spine (n = 31). With the help of the author’s questionnaire, the peculiarities of the PA of women were assessed at different age periods of life and at the time of the survey. Results. We did not find significant differences in the frequency and types of sports in childhood between the groups depending on vertebral fractures. Most of the women with vertebral fractures (85.7 %) maintained regular physical activity, sports in childhood up to 10 years (41.7 % in the control group, p = 0.04), moreover, in 57.1 % of the surveyed, these activities lasted 1–4 years and did not differ from the indicator of the control group. The type, frequency and duration of FFU training and PH procedures, as well as the level of physical activity, did not significantly differ in patients depending on the presence of vertebral fractures, but the group of women regularly exercising in sports sections was significantly higher among patients with vertebral fractures (41.9 %) compared with women without vertebral fractures (10.7 %, p = 0.0002). In addition, the part of the women in the control group who regularly maintained a sufficient level of PA (6 or more hours a day) was significantly higher (14.3 %) compared with the corresponding result of the main group (3.2 %, p = 0.04). Conclusions. Women with vertebral body fractures are more likely to engage in PE in sports sections and have a lower level of total PA compared to patients without vertebral fractures. The regularity, duration of PE, and the age at which sports start in childhood may influence the risk of osteoporotic fractures of the vertebral bodies in postmenopausal women, which requires further study.

Keywords: physical activity; sports; osteoporosis; childhood; postmenopausal women; vertebral fractures

Introduction

For today, the discussions regarding the long-term impact of regular childhood sports for the prevention of bone quality loss in postmenopausal women [1–3], as well as the positive impact of a sufficient level of physical activity (PA) for the prevention of osteoporotic fractures [4–8] are ongoing. Some literature reviews demonstrate the absence of a long-term effect of the regular PA and physical exercise (PE) in childhood and adolescence on the bone state in adulthood, which, in particular, may be a consequence of the lack of prospective long-term studies [2]. However, taking into account the results of the researches in recent years that the occurrence of osteoporosis in adults is associated with the formation of peak bone mass in childhood and adolescence, it is probably necessary to be focused on the primary prevention of osteoporosis at a young age, promoting the formation of the maximum peak bone mass in the period of maturation of the skeleton. An increasing understanding of the importance of a healthy lifestyle in children and adolescents, regular sports and PA for the prevention of osteoporosis and its serious complications — osteoporotic fractures [1, 4] is relevant.
In accordance to the data of meta-analysis [9] as for the influence of regular sports or any type of PA on bone tissue status in different groups of patients, it was established that there is a slight positive effect of PA only in boys in the pre- or early puberty stage (relative risk (RR) = 0.17; 95 % confidence interval (CI): 0.02 – 0.32), but influence in girls during puberty stage (HR = -0.01; 95 % CI: -0.18 – 0.17), young men (HR = 0.10; 95 % CI: -0.75 – 0.95), adolescent girls (HR = 0.21; 95 % CI: -0.53 – 0.97), women in the premenopausal (HR = 0.00; 95 % CI: -0.43 – 0.44) and postmenopausal periods (HR = 0.00; 95 % CI: -0.15 – 0.15) was not obtained.

The data of the modern literature confirm that impact exercises improve bone mineralization in prepubertal children, and bone mineral density (BMD) was significantly higher in adolescent athletes engaged in wagon-loading exercises. Aerobic (cardio) exercises in combination with anaerobic (strength) and coordination ones increase BMD, reduce the severity of vertebral pain, improve the condition of the vestibular apparatus and the quality of life in young people and premenopausal women, and also prevent the risk of falls, which is very important for the females in the postmenopausal period and elderly men. In addition, the authors note that the type of exercise and sport, used by a person, should be selected in accordance to the life cycle [3, 10-13]. Therefore, multicomponent and individually developed complexes of PE in accordance to the life cycle are important strategies for the prevention of osteoporosis and vertebral fractures.

The purpose of the study was to evaluate the influence of PA in childhood on the state of bone tissue, physical capabilities of postmenopausal women with osteoporosis and vertebral fractures.

Materials and methods

115 postmenopausal women at the age from 50 up to 89 years have been examined in a cross-sectional study in the Ukrainian Scientific and Medical Center of the Problems of Osteoporosis, D. F. Chebotaryov Institute of Gerontology of the National Academy of Sciences of Ukraine. The subjects were divided into two groups: I (control) group — the women without any previous osteoporotic fractures (n = 84), the second (main) group — the patients with vertebral fractures of the thoracic and/or lumbar spine (n = 31). Peculiarities of menstrual function (age of menarche, menopause, duration of postmenopause period), body parameters (height, body weight, body mass index) were studied, and indices of PA using the author’s questionnaire (regarding the level of PA: types of PA, sports, regularity, duration, types of PE, body position during the day) were assessed. The subjects filled out the questionnaires independently under the supervision of the researcher.

Statistical processing of the research results was carried out using the "STATISTICA-10.0" program package. Differences of the indices between groups were established using the Student’s test, χ² test, and the test of the comparison of two proportions. p < 0.05 was considered to be the critical level of significance.

Results

The analysis of the results had proved the absence of the significant differences of the menarche age (respectively, in women of the control and main groups, 13.7±1.4 and 13.8±1.5 years (t = 0.46; p = 0.64)), the age of menopause (respectively, 49.3±4.7 and 48.6±4.3 years (t = 1.08; p = 0.28)) and the duration of the postmenopausal period (respectively, 17.1±9.1 and 19.1±8.2 years (t = 1.65; p = 0.10)).

The assessment of the parameters of the physical examination revealed reliable lower parameter of height in patients with vertebral fractures compared to the corresponding indices in the control group (155.9±6.2 and 158.0±5.6 cm (t = 2.59; p = 0.01)). Also, their body weight was significantly lower (respectively, 69.6±13.4 and 80.4±15.7 kg (t = 5.10; p = 0.000001)) as well as body mass index (respectively, 28.6±4.7 and 32.2±5.9 kg/m² (t = 4.62; p = 0.000006)). Probably, a decrease in height may be associated with the presence of vertebral fractures, and low body weight is an independent factor of osteoporotic fractures, which coincides with the results of the existing scientific studies [14, 15].

During the evaluation of the part of women in the corresponding group (%) who are regularly going in for sports or any other type of PA in the childhood and youth, we did not find significant differences between groups depending on the presence of vertebral fractures (control group — 28.6 %, the main group — 22.6 % (p = 0.52)). However, assessing the regularity of sports activities by women in the childhood and young age it was revealed a tendency (in accordance to the results of the test of comparing of two proportions: p = 0.10) to more frequent regular sports activities in patients of the control group (27.4 %) compared to the corresponding indices of the main group (12.9 %).

We did not find any reliable differences between the groups depending on the presence of vertebral fractures regarding the types of PE that the patients did in childhood (cyclical types of exercises, sports types of games). Also, it was found that 58.3 % of the subjects of the control group and 57.1 % persons of the main group had been involved in cyclical sports (p = 0.96). The corresponding results for playing sports were 33.3 % for the control group and 28.6 % for the main group (p = 0.84). But when evaluating the complex- coordinating exercises that the women did in childhood, it was found that subjects of the control group had been engaged in this type of exercise significantly more rarely (p = 0.01) (45.8 %) compared to the women of the main group (100 %).

In addition, the analysis of sports activities duration in childhood among women who were engaged in them, did not establish no reliable differences in the groups depending on the presence of vertebral fractures. Thus, during 1-4 years, 50.0 % of the subjects of the control group and 57.1 % of the women of the main group regularly played sports (p = 0.74), 5-9 years – 37.5 % of the subjects of the control group and 42.9 % of the patients of the main group (p = 0.77). However, in the control group, 12.5 % of the women who had been involved in sports for more than 10 years were found, while we did not find a single woman in
the main group whose duration of PA trainings in childhood was more than 10 years.

The analysis of the indices of the age at which women started regular trainings in various types of PA in childhood found that its average indices was 8.5 ± 2.4 years for the subjects of the control group and 7.3 ± 1.8 years for the patients of the main group, respectively (p = 0.11), although it did not differ reliably depending on the presence of vertebral fractures. However, the assessment of the distribution of the patients regarding to the age at which PE were started in childhood revealed significant differences between the groups. Thus, in the control group, 41.7 % of people started trainings at the age from 5 to 9 years old, while in the main group, the corresponding indices was 85.7 %. 58.3 % patients of the control group and 14.3 % of the subjects of the main group started their regular classes (p = 0.04) from the age of 10 years old.

The assessment of the level of PA (physical therapy, trainings in sections) in female at the time of the survey did not establish reliable differences between the groups. The indices of the subjects with vertebral fractures (67.7 %) did not differ from the results of the control group (66.7 %; p = 0.91). However, among the patients of the main group, the share of women regularly working in the sections was significantly higher (41.9 % of the subjects), compared to 10.7 % of the subjects of the control group (p = 0.0002).

The analysis of the physical exercises duration among women who regularly engaged in PA established that its average index was 5.3 ± 5.2 years for the subjects of the control group and 5.6 ± 12.8 years for the patients in the main group respectively and probably did not differ depending on the presence of osteoporotic vertebral fractures. In the distribution of women depending on the duration of the trainings of PE, no reliable differences between the groups were also established depending on the presence of vertebral fractures. Thus, it was found that 80.4 % persons of the control and 61.9 % of women of the main group had been engaged in sports during 1-4 years, 8.9 % of the patients of the control group and 28.6 % of the subjects of the main group — for 5-9 years, more than 10 years — 9.5 % of the patients of the control and 10.7 % of women of the main group.

In addition, the assessment of the physical trainings duration did not find any significant differences between the groups. Thus, in the majority of the subjects (75.0 % of the control group and 85.7 % patients of the main one), the duration of one training was 10-30 minutes, and 25.0 % of the control group and 14.3 % of the patients of the main group regularly had performed physical trainings for 45-60 minutes (p = 0.30).

Also, the analysis of the types of PE that the subjects perform on a regular basis during the PE did not establish any significant differences between the groups depending on the presence of fractures. Thus, cardioexercises were performed by 37.5 % of the subjects in the control group, while in the main group the corresponding index was 28.6 % (p = 0.51). Strength exercises were regularly performed by 55.4 % of the subjects of the control group and 47.6 % of the women of the main group (p = 0.58). Coordination exercises and body flexibility exercises were regularly performed by 39.3 % of the patients without vertebral fractures and 42.9 % of women with vertebral fractures (p = 0.74).

We did not find any significant differences of the duration of total PA (not taking into account physical therapy) between the patients depending on the presence of vertebral fractures. Thus, 28.6 % of the subjects of the control group and 38.7 % of the women of the main group were physically active on a regular basis during 1-2 hours per day (p = 0.30), 3-5 hours— 57.1 % of the patients of the control group and 58.1 % of the patients of the main group, respectively (p = 0.92). It was established that only part of the patients in the control group who were physically active 6 or more hours per day (14.3 %) was significantly higher compared to the corresponding result of the main group (3.2 %) (p = 0.04).

The analysis of the indices of the level of physical exertion used by women in their daily activities revealed that 75.0 % of females without vertebral fractures and 80.6 % of the patients with them performed mild and moderate physical exertion (washing dishes, floors, laundry), while 25.0 % of the subjects of the control group and 19.4 % of the subjects of the main group could perform heavy work (work in the garden, moving, lifting heavy objects) (p = 0.50).

The assessment of the body position most often chosen by the patients during the day (lying, sitting, standing, moving) did not find any significant differences depending on the presence of vertebral fractures. The patients of the main group (32.3 %) and the women of the control group (44.0 %) had an equally insufficient level of physical activity, and 67.7 % of females with vertebral fractures and 56.0 % of women without them were equally regularly in motion and (p = 0.24).

**Discussion**

For today, it is known that a sedentary lifestyle is observed in people of various ages and leads to the development of many chronic diseases, in particular, disorders of the musculoskeletal system, premature aging and death [16-18].

Physical activity is an important method of primary prevention and treatment for the most of chronic diseases, in particular, sarcopenia, osteoporosis and its complications, accelerated biological aging [19]. The scientists have established that regular PE and sports during youth have a positive influence on the formation of the peak of bone mass of the adolescents and the state of bone tissue during further life [20-24].

The analysis of the connection between the PA level at the age of 15.18 and 23 years and the bone indices among 3,454 young people (women and men) established [17] that the PA level among 15-year-old adolescents was probably associated with lumbar BMD (β = 0.061 g/cm²; 95 % CI: 0.02-0.11). A positive effect of a dose of PA on BMD among 18-year-old adolescents was also revealed. The men at the age of 23 years, who had been in the two highest quartiles for PA, had significantly higher BMD indices in all parts of the spine compared to the parameters of the subjects who had been in the lowest quartile. BMD indices were higher among those men (30 years) whose PA level was high in at least one of the age groups (18 or 23 years) compared to the seden-
tary peers in both groups. The woman at the age of 23 years, who had been in the highest quartile for PA level had higher femoral neck BMD indices at the age of 30 years (β = 0.02; 95% CI: 0.001-0.04).

In another study, the scientists had found that the time of bone mass accumulation and bone tissue mineralization in students (19-23 years old) who regularly play sports and their peers who have an insufficient level of PA are significantly different. It was noted that bone density depends on the type of training and increases due to the rising of athlete’s skill. Thus, the greatest dynamics of the speed of sound ultrasound parameter was found in track and field athletes (from 4041.17 ± 82.89 m/s at the age of 19 years old to 4065.13 ± 90.75 m/s at the age of 23 years old; (p < 0.05)) , which is also related to the specifics of motor activity and the level of physical exertion (cyclic, complex-coordinating, speed-strength, etc.). The corresponding index for the students who had led a sedentary lifestyle was 4012.09 ± 110.02 m/s at the age of 19 years old and 4058.30 ± 117.98 m/s at the age of 23 years old; (p < 0.05)[1].

For today, due to the lack of the prospective long-term studies, the expected long-term sustainable effect of regular PA and PE in childhood and adolescence on the strength of bone tissue in adulthood has not been definitively established [2, 20-24], therefore the researches about the connection between the level of PA, going in for sports in childhood and BMD status in postmenopausal women, remains relevant.

We hadn’t found any significant differences in the frequency and types of sports activities in childhood between the groups depending on the presence of vertebral fractures. Most of the women with vertebral fractures (85.7 % ) maintained regular PA, sports in childhood up to the age of 10 years old (41.7 % in the control group, p = 0.04), in addition, in 57.1 % of the examined these classes had been lasted for 1-4 years and did not differ from the index of the control group. The type, frequency and duration of PE classes and therapeutic gymnastics procedures, as well as the level of physical exertion probably did not differ in patients depending on the presence of vertebral fractures, but the group of the women who regularly had practiced in sports sections was significantly higher among the patients with vertebral fractures (41.9 %) compared to the females without them (10.7 %, p = 0.0002). In addition, the proportion of the women in the control group who regularly maintained a sufficient level of PA (6 or more hours per day) was significantly higher (14.3 %) compared to the corresponding result of the main group (3.2 %, p = 0.04).

The limitations of this study are its design (one-center, cross-sectional), small sample size, selection of only female subjects, and that analysis was conducted only in subjects with one location of osteoporotic fractures (vertebral ones), which does not allow to do general conclusions about the long-term influence of the regular PA on the rates of bone tissue loss and risk of osteoporotic fractures in the elderly persons in general, but only in postmenopausal women with vertebral fractures in particular, that needs further studying.

Conclusions

Women with vertebral fractures are more often engaged in PA in sports sections and have a lower level of total PA compared to the subjects without vertebral fractures. The regularity, duration of PA and the age of starting sports in childhood may have an impact on the risk of osteoporotic vertebral fractures in postmenopausal women, which requires further study.

Conflict of interests. The author declares that there are no conflicts of the interests and financing during the preparation and publication of the article.

References


Вплив фізичної активності в дитинстві на стан кісткової тканини, фізичні можливості постменопаузальних жінок з остеопорозом та вертебральними переломами

Резюме. Актуальність. На сьогодні в наукових дослідженнях продовжується дискусія щодо тривалого впливу регулярної фізичної активності на стан кісткової тканини, фізичні можливості постменопаузальних жінок з остеопорозом та вертебральними переломами.

Мета. Оцінити вплив фізичної активності (ФА) у дитинстві, фізичні можливості постменопаузальних жінок з остеопорозом та вертебральними переломами.

Матеріал та методи. Вони включали в себе обстеження 115 жінок віком 50—89 років. Для аналізу якості фізичної активності були застосовані наступні методи: анкета, інтерв'ю та діагностичні методики.

Результати. Вплив фізичної активності в дитинстві на стан кісткової тканини, фізичні можливості постменопаузальних жінок з остеопорозом та вертебральними переломами потребує подальшого вивчення.

Ключові слова: фізична активність; спорт; остеопороз; дитинство; постменопаузальні жінки; вертебральні переломи.