Medicina Sportiva, Vol. 10 (3): 81-84, 2006

EFFECT OF CALCIUM INTAKE ON BONE PARAMETERS IN WOMEN TRAINING AND NOT-TRAINING IN THE PAST BEING IN THE POSTMENOPAUSAL PERIOD

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Abstract

The study was aimed at evaluating the effect of the current intake of calcium on the level of bone parameters of women being in the postmenopausal period. The study involved 51 women aged from 50 to 62 years, including 32 former sportswomen and 19 women who did not practice any sports in the past. Bone mineralization (BMC) and density (BMD) were determined in the lumbar region of the spine (L_2-L_4) with the DEXA method, whereas bone strength (Stiffness coefficient) in the calcaneal bone with the ultrasonic method. The nutritional pattern (calcium intake) was assessed based on three 24-hour dietary recalls, with the use of a software based on nutritional tables.

The analysis of the results obtained demonstrated that ca. 19% of the former sportswomen consumed calcium in a deficient amount, i.e. below 67% of the safe level of intake, whereas in the case of the women not practicing sports in the past it referred to 42% of the examined. The mean values of BMC and BMD were lower in the women with deficient intake of calcium (below 2/3 of the safe level of intake) compared to the other women, i.e. by 12% and 9% (former sportswomen) and by ca. 4% and 7% (control group). It was also demonstrated that in women characterized by the proper intake of calcium the mean value of the Stiffness coefficient was higher by 6% (former sportswomen) and by 9% (control group).

The results obtained enable concluding that there exists a relationship between calcium intake by the women examined and the bone parameters analyzed.

Key words: women, bone parameters, calcium intake

Introduction

Osteoporosis is a disease of the skeleton characterized by a risk of bone fractures as a result of reduced mechanical resistance. The risk of osteoporotic fractures increases exponentially with age. This is due to the loss of bone mass and deterioration of its quality, both proceeding with age. According to WHO (1), in an aging society, apart from chronic diseases of the cardiovascular system and neoplasmatic diseases, osteoporosis is becoming one of the biggest challenges. Estimated data depicting the spreading of osteoporosis in Poland indicate that ca. 8-9 mln of people: 5 mln of women and 3-4 mln of men, are potentially at risk of that disease (2). The most serious social problem is posed by type I involutional osteoporosis (postmenopausal) constituting 4/5 of cases in 80% group of primary osteoporoses. It is estimated that in Poland that disease affects 20-30% people over 50 years of age (3, 4).

An important environmental factor that affects the growth and stabilization of osseous tissue is nutritional pattern. A number of studies have demonstrated a positive relationship between nutritional patterns and bone mineralization, especially in women in the postmenopausal period (5, 6). A high supply of that element does not increase the bone mass, yet it slows down its loss (7). Currently, it is assumed that the intake of ca. 1000 mg Ca/day by women taking estrogens and that of 1500 mg Ca/day by women not using the substitutive hormonal therapy (SHT) is likely to inhibit bone resorption and bone mass loss in the range of 1-2% annually (8).

The study was aimed at evaluating the effect of the current intake of calcium on the level of bone parameters in women being in the postmenopausal period.

Material and methods

The study involved 32 former sportswomen aged 50-62 years who finished their sports career ca. 20 years ago (17 swimmers, 8 canoeist, 7 fencers). In the past, they presented a high sports level, majority of them were representatives of the National Team of Athletes. A control group was constituted by women in the same age but not practicing sports in the past (n=19). A criterion of selection to the control group was the age of menopause similar to that of the former sportswomen. Investigations were carried out under grant No. 3 PO5D06423 of the State Committee for Scientific Research.

Bone mineralization BMC (g) and bone density BMD ($g \cdot cm^{-2}$) were determined with the densitometric method (DEXA) in the lumbar region of the spine (L_2-L_4), which is one of the fourth measuring sites for risk

Table 1. *Anthropometric characteristics of the former sportswomen and women not practicing sports in the past (control group)*

No.	Women examined	n	Age (years)	Body mass (kg)	Body height (cm)	BMI (kg/m²)	Adipose tissue (%)
1	Swimmers	17	56.82 ± 6.78	68.6 ± 11.9	165.4 ± 5.9	24.56 ± 3.07	29.9 ± 5.5
2	Canoeists	8	51.88 ± 2.42	75.9 ± 17.2	162.9 ± 3.8	29.18 ± 7.12	32.5 ± 6.9
3	Fencers	7	54.71 ± 6.39	64.9 ± 2.9	161.4 ± 5.4	24.83 ± 1.14	33.7 ± 7.1
4	Control group	19	53.63 ± 5.03	66.2 ± 7.7	162.1 ± 4.3	25.13 ± 3.17	35.4 ± 8.6

Table 2. *Mean daily intake of calcium by the women examined (± SD)*

Group investigated	n	Calcium (mg)
Swimmers	17	740.1±224(85.4)
Canoeists	8	624.7±80(77.0)
Fencers	7	863.5±130(104.5)
Control group	19	645.3±264(80.7)

*brackets contain the per cent of meeting the norm at the safe level of intake

assessment of bone fractures accepted by the WHO (1, 9). The quality of bones was assayed in the calcaneal bone with the ultrasonographic method (QUS) by determining the value of the Stiffness coefficient. Nutritional pattern (calcium intake) was evaluated based on 24-h dietary recalls (two working days and one day free of work) with the use of "Dietus" software based on nutritional tables. The nutritional studies were carried out two times (in a year interval), yet the second study was restricted to the qualitative assessment of eating habits taking into account changes that proceeded between I and II examination. In addition, basic somatic measurements were taken (body height and mass), that were next used to calculate the body mass index (BMI), and the level of adipose tissue was determined with the method of Durnin and Womersley (10).

In order to determine differences in the mean values of the parameters analyzed in particular groups, use was made of an analysis of variance and Tukey's test for unequal numbers.

Results

Based on anthropometric data included in Table 1, no significant differences were found in body height, body mass, BMI and adipose tissue between the former sportswomen and the control group.

The analysis of the daily intake of calcium based on dietary recalls was presented in Table 2. Insufficient intake of that element was recorded in the group of former swimmers, canoeists and women from the control group, i.e. 85.4%, 77% and 80.7% of the safe level of intake, respectively. Whereas daily food rations of the formers fencers were found to cover calcium demand in 104.5%.

In evaluating calcium intake in terms of a risk of its deficiency in the body, the intake accounting for ≤ 2/3 (67%) of the safe level was accepted as a criterion. Once all the former sportswomen were combined into one group, it was found that ca. 19% of them ingested calcium in an insufficient amount, i.e. below 67% of the safe level. In the case of the control group, it applied to as much as 42% of the women (Fig. 1).

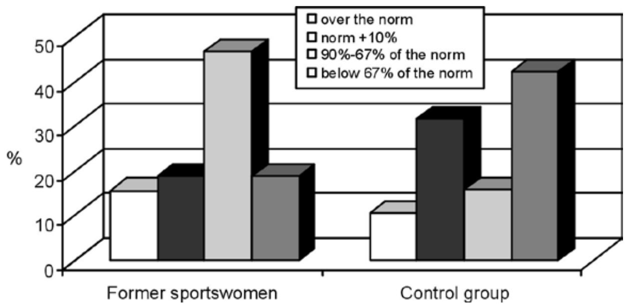

Fig. 1. *Per cent of the women examined meeting the safe level of calcium intake*

Fig. 2. *Degree of bone mineralization (BMC) depending on the current intake of calcium*

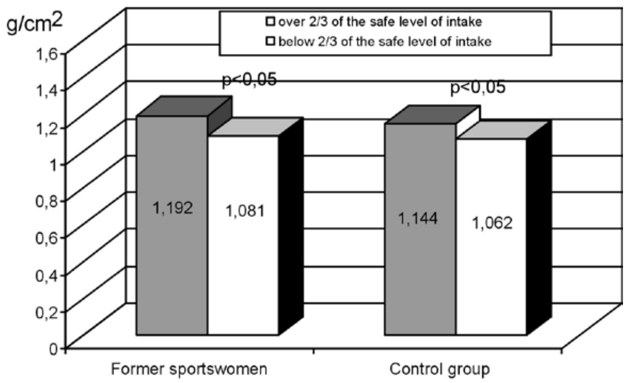

Fig. 3. *Bone density (BMD) in the lumbar region of the spine (L2-L4) depending on the current intake of calcium*

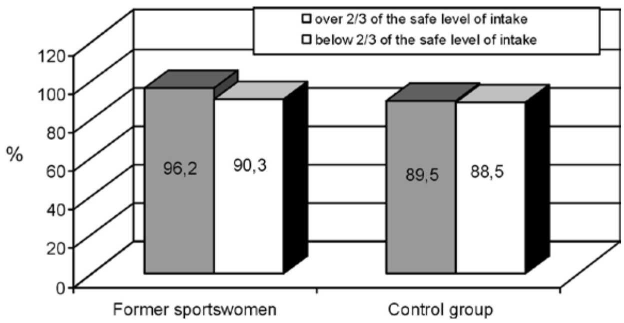

Fig. 4. *Values of the Stiffness coefficient in the women examined depending on the current intake of calcium*

Figures 2-4 depict a dependency between current intake of calcium at the level higher and lower than 2/3 of the safe level and values of bone parameters: BMC, BMD and Stiffness coefficient. The analysis of data demonstrated a higher degree of bone mineralization in women with calcium intake higher than 2/3 of the safe level, both in the group of the former athletes and in the control one (Fig. 2). In the case of the former sports women, mean values of BMC were higher (although statistically insignificantly) by 6.35 g (12%) as compared to the other women in that group and by 1.79 g (4%) as compared to the non-training women compared. The same dependency was observed in the case of bone density (Fig. 3). In both groups, women with insufficient calcium intake had significantly lower mean values of BMD as compared to the women characterized by a higher calcium intake. The differences accounted for 0.11 $g \cdot cm^{-2}$ (9%) in the case of sportswomen and for 0.08 $g \cdot cm^{-2}$ (7%) in the case of the control group. In analyzing values of the Stiffness coefficient (Fig. 4), it was found that in the women with insufficient calcium intake its mean values fluctuated between 90.3±7.6% (athletes) and 88.5±12.1% (controls), whereas in the women characterized by the proper intake of calcium the values of the coefficient were higher and reached 96.2±15.4% for the sportswomen and 89.5±6.1% for women from the control group. The differences were, however, not statistically significant.

None of the women examined, neither from the group of former athletes nor from the control group, provided information on changes in their nutritional patterns between I and II examination.

Discussion

Despite several decades of research, the effect of calcium intake on bone status in women after the menopause still remains a disputable subject. Results of investigations addressing that problem are not unanimous, and often contradictory. Nevertheless, a number of studies have demonstrated a positive dependency between the intake of calcium and status of osseous tissue (11, 12).

Calcium deficiency evoked by its insufficient intake or other factors leading to disturbance of calcium metabolism in the body plays a significant role in pathogenesis of osteoporosis, beginning from the period of early childhood until old age (13). The problem gains special significance in the light of epidemiological data indicating that calcium intake in Poland is insufficient both in adulthood and childhood as well as in the adolescent period. The mean daily supply of that element in a statistical Pole is estimate at a level of 400 mg/day (14). Investigations of Hoszowski et al. (15) indicated that out of 607 randomly selected inhabitants of Warsaw over 50 years of life, a low calcium intake with a diet (<800 mg/day) was declared by 90% of the respondents, yet the mean intake of calcium accounted for 490 mg/day. Likewise in our study, an insufficient supply of that macroelement was observed with daily food rations of both the former athletes (except fencers) and women who never practiced any sports. In ca. 19% of the former athletes and in 43% of the control women, the intake of calcium did not reach 2/3 of the safe level, which poses a real risk to their health, especially to the proper mineralization of osseous tissue. The women analyzed were in the postmenopausal period in which – due to drastically decreased production of estrogens – calcium resorption diminishes, which consequently leads to disorders of osseous tissue metabolism. Nowadays, there exists a body of convincing evidence that in the case of postmenopausal osteoporosis, a calcium-rich diet inhibits the loss of bone mass (16, 17).

American studies of healthy women after the menopause have revealed that density of lumbar vertebrae bones was considerably higher in women ingesting 777 mg Ca/day as compared to those with daily supply of that element exceeding 405 mg Ca/day (18). Also Matkovic et al. (19) demonstrated a ca. 70% decline in the number of fractures of the closer end of femoral bone in a population from the former Yugoslavia inhabiting regions where water was characterized by a high calcium content, as compared with women inhabiting areas with low calcium content of water. There are also reports indicating the occurrence of a lower risk of fractures in the region of upper end of femoral bone in women consuming meals with a proper content of calcium. Our investigations also confirmed the positive impact of calcium intake on bone density in the groups of both women training and not-training in the past. Women characterized by a proper calcium supply (above 2/3 of the safe level of intake) had significantly higher mean values of BMD in the lumbar region of the spine as compared to women ingesting calcium in amounts below 2/3 of the safe level of intake.

There are, however, numerous scientific reports in which the positive effect of an increased intake of calcium on osseous tissue of women after the menopause has been found controversial. Results of studies by Ettinger et al. (21) have demonstrated that in the first few years after the menopause, supplementation with calcium has no significant effect on the osseous tissue. Also Reed et al. (22) reported that in postmenopausal women applying a calcium-rich diet (≥RDA), the involutional decrease in BMC and BMD values was the same as in women staying on a calcium-poor diet (<RDA).

An attempt of explaining discrepancies in studies devoted to the calcium-bone density relationship is the concept of threshold values elaborated by Matkovic and Heaney (23). According to those scientists, calcium is a macroelement with a threshold character, which means that there exists a correlation between its intake and retention in a body only to some boundary value. A further increase in calcium intake dose not result in its higher accumulation in the skeleton.

Conclusions

1. It may be concluded that a proper intake of calcium (over 2/3 of the safe level) in the postmenopausal period has a positive impact on maintaining the optimal bone mass, in respect of age, evaluated in the lumbar region of the spine and in the calcaneal bone.
2. Calcium intake exceeding 2/3 of the safe level – declared by 81% of the former sportswomen, as compared to 58% of women from the control group – is likely to indicate that the athletes maintained proper eating habits even after the end of their sports career.
3. Insufficient (below 2/3 of the safe level) intake of calcium by the women examined indicated the need for periodical control of bone density, according to a suggestion of the Scientific Board of the Polish Foundation for Osteoporosis, as well as for education on that issue.

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Received: August 18, 2006
Accepted: November 22, 2006
Published: November 30, 2006

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Author's contribution
A – Study Design
B – Data Collection
C – Statistical Analysis
D – Data Interpretation
E – Manuscript Preparation
F – Literature Search
G – Funds Collection