

Part I. Diseases and problems distinguished by WHO and FAO
Dział I. Choroby i problemy wyróżnione przez WHO i FAO

EVALUATION OF BONE MINERAL DENSITY OF STUDENTS FROM THE POPE JOHN PAUL II STATE SCHOOL OF HIGHER EDUCATION IN BIAŁA PODLASKA

OCENA GĘSTOŚCI MINERALNEJ KOŚCI STUDENTÓW PAŃSTWOWEJ SZKOŁY WYŻSZEJ IM. PAPIEŻA JANA PAWŁA II W BIAŁEJ PODLASKIEJ

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- A. Study design/planning
zaplanowanie badań
- B. Data collection/entry
zebranie danych
- C. Data analysis/statistics
dane – analiza i statystyki
- D. Data interpretation
interpretacja danych
- E. Preparation of manuscript
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- F. Literature analysis/search
wyszukiwanie i analiza literatury
- G. Funds collection
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Summary

Background. Nutritional status is one of the factors enabling prediction the possibility of emergence and development of civilization diseases. Correct mineral nutritional status is important and particularly proper bones calcification.

The aim of the work was to assess bone mineral density of female and male students from the Pope John Paul II State School of Higher Education in Biała Podlaska. Consumption of products which are the main source of calcium in the students' diet was assessed as well.

Material and methods. Bone mineral density was measured by densitometry method. The consumption of food that are sources of calcium in students' diet was assessed by questionnaire.

Results. In groups of women, changes characteristic of osteopenia were showed among 54.9 % women to 25 years and 67.6 % in the older group. Changes characteristic of osteoporosis were found too. In the group of men aged up to 25 changes typical of osteopenia revealed 62.3% and characteristic of osteoporosis 6.6% of examined students. Among 9 older students changes typical of osteopenia were found among 44.4%. Dairy products were main source of calcium in students' daily food rations.

Conclusions. There is a need to take action in the field of nutritional health education, including the practical application of knowledge in the prevention of osteopenia and osteoporosis, addressed to young people. Students from the Pope John Paul II State School of Higher Education in Biała Podlaska should be included in the program of nutrition education program for the prevention of osteoporosis

Keywords: bone mineral density, osteopenia, osteoporosis, source of calcium in the diet

Streszczenie

Wprowadzenie. Stan odżywienia jest jednym z czynników umożliwiających możliwość prognozowania powstania i rozwoju chorób cywilizacyjnych. Ważny jest prawidłowy stan odżywienia mineralnego, a szczególnie prawidłowe uwapnienie kości.

Celem pracy była ocena gęstości mineralnej kości studentek i studentów Państwowej Szkoły Wyższej im. Papieża Jana Pawła II w Białej Podlaskiej. Oceniono także ilość produktów spożywanym przez studentów, będących podstawowym źródłem wapnia w ich diecie.

Materiał i metody. Uwapnienie kości mierzono metodą densytometryczną na kości przedramienia, przy użyciu aparatu EXA 3000. Konsumpcja produktów spożywczych będących źródłem wapnia w diecie studentów oceniana była metodą ankietową.

Wyniki. W obydwu badanych grupach duży odsetek kobiet wykazywał zmiany charakterystyczne dla osteopenii – 54,9% u kobiet do 25 lat i 67,6% w grupie starszych studentek. Wykazano także zmiany charakterystyczne dla osteoporozy. W grupie mężczyzn do 25 lat zmiany typowe dla osteopenii miało 62,3%, a dla osteoporozy 6,6%. Wśród 9 starszych studentów zamiany w uwapnieniu wskazujące na osteopenię miało 44,4% badanych. Produkty mleczne są głównym źródłem wapnia w całodziennych racjach pokarmowych studentów.

Wnioski. Istnieje potrzeba podejmowania działań w zakresie żywieniowej oświaty zdrowotnej, obejmujących praktyczne wykorzystanie wiedzy w profilaktyce osteopenii i osteoporozy, skierowanych do osób młodych. Studenci z Państwowej Szkoły Wyższej w Białej Podlaskiej powinni być objęci programem edukacji żywieniowej w zakresie profilaktyki osteoporozy.

Słowa kluczowe: gęstość mineralna kości, osteopenia, osteoporoza, źródła wapnia w diecie

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Background

Over the last few years health problems of Polish society have changed. Among the reasons for these changes is lifestyle of individual social groups.

Nutritional status is one of the factors enabling prediction the possibility of emergence and development of civilization diseases. In addition to protein-energy nutritional status, correct mineral nutritional status is important as well, and particularly proper bones calcification. Human's skeletal system is a place where muscles are attached, protects internal organs and is a storage of calcium, phosphorus and magnesium. There are constant changes of bone mass taking place in human skeleton, depending on human age. Period of childhood and adolescence have a fundamental influence on skeleton mineralization. Quick construction of skeletal system takes place and continues till epiphysis closure. At the age of about 25 years old, human being reaches a peak bone mass and from that moment osteogenesis gradually undergo inhibition. Osteoclastic cells which have dissolving and resorption abilities, take advantage over osteogenic cells. As a result of these processes, bones slowly reduce their density and mass - less and less bones have dense structure and increasingly take on spongy form. All changes take place as a result of complex regulatory mechanisms based on genetic factors and humoral system activity. Together with aging of the organism, loss of calcium from bones increases, about 0.3% of the total bone mass per year. This process is much slower among men than among women. Therefore it is so important for osteoporosis prophylaxis to achieve maximum peak bone mass in adolescence. Peak bone mass is a major forecast factor of osteopenia or osteoporosis occurrence as well as subsequent fractures in further periods of life [1,2]. Value of peak bone mass is affected by endogenous factors (genetic, race, gender) and exogenous agents (diet, physical activity, nutritional status, diseases, etc.) [3]. In the further decades of life, constant loss of bone tissues takes place, hence the low peak bone mass is associated with risk of osteoporosis occurrence in later period [4].

One of the major factors affecting correct development of bone tissue is proper nutrition, and especially appropriate dietary supply of calcium and vitamin D. Calcium makes 1.4-1.6% of the total body weight, and 99.85% is found in bones as calcium phosphate salts. Bone tissue is a reservoir of calcium, and calcium homeostasis has great influence on it, both during achieving peak bone mass, and through the whole life. Calcium deficiencies in a diet may lead to decalcification and decrease of bone mineral density, which in turn can cause occurrence of osteopenia and osteoporosis [5]. Although disturbances in skeleton calcification affect mostly elderly people, however, calcium deficiency in a diet of Polish population and their lifestyle cause that more and more often we have to deal with changes characteristic of osteopenia or osteoporosis among young people as well.

The aim of the work was to assess bone mineral density of female and male students from the Pope John Paul II State School of Higher Education in Biała Podlaska (SHSBP). Consumption of products which are the main source of calcium in the students' diet was assessed as well.

Material and methods

Full-time and part-time students underwent evaluation of the bone mineral density. Total of 240 persons, including 170 female students and 70 male students, took part in this examination. Age of 78.2% of female students didn't exceed 25 years old, and 21.8% were older. Similarly, in the group of men -87.1% of them were aged up to 25, while 12.9% was older. The examined students were divided into age groups: up to 25 years old and above this age.

Bone mineral density was measured by the DEXA densitometry on forearm bone of non-prevailing arm, using the EXA 3000 apparatus. Bone mineralization was evaluated based on the T-score value, in which average value and standard deviation were assumed as reference values. As a norm the T score value up to -1 was accepted. It means that value of bone mineral density is not lower than one standard deviation below average value. The T-score value between -1 and -2.5 is characteristic for osteopenia, while the value below -2.5 for osteoporosis.

Based on the survey conducted among students, percentage of subjects eating with individual meals products that were a source of calcium was estimated.

Results

A group of female students aged up to 25 that underwent examination of the bone mineral density, were characterized by body height and body weight of 166.1 ± 6.2 cm and 63.9 ± 14.3 kg, respectively. Students older than 25 years old, were about 2.8 cm lower and by 2.3 kg heavier than their younger colleagues. The Body Mass Index (BMI) in both groups of examined women was normal. Women in a younger age group revealed lower percentage of fat content (table 1).

Table 1. Basic anthropometric parameters of examined female students

| Age of subjects (years) | Body mass (kg) | Body height (cm) | Body Mass Index kg/m ² | % fat content | Lean body mass (kg) |
|--------------------------------|---------------------------|----------------------------|-----------------------------------|-------------------------|-------------------------|
| 21.3±1.3 17 – 24 n - 133 | 63.9±14.3 42.9 – 134.0 | 166.1±6.2 142.6 – 195.6 | 23.1±4.6 16.0 – 46.3 | 24.8±4.2 12.9 – 35.3 | 47.3±8.7 36.8 – 90.0 |
| 36.9±10.5 25 – 57 n-37 | 66.2±12.5 48.8 – 110.6 | 163.3±5.7 150.2 – 179.4 | 24.8±4.7 18.0 – 42.1 | 26.4±5.4 12.8 – 37.9 | 48.3±7.6 37.6 – 68.7 |

In the numerous group of women aged up to 25, proper calcification was found among 19.5% of subjects, while in the group of older female students – 18.9%. In both examined groups large percentage of women revealed changes characteristic of osteopenia – 54.9% among women aged up to 25, and 67.6% among older female students. In both groups of female students changes characteristic of osteoporosis were found. In a group of female students aged up to 25, these changes were found among 25.6%, while in the older group changes in skeleton calcification characteristic of osteoporosis were found in 13.5% of examined female students. (Table 2).

Table 2. Bone calcification among female students taking into account age groups (%)

| Bone calcification / Group of subjects | Number of subjects | Norm T-score > -1 | Osteopenia -1 > T-score > -2.5 | Osteoporosis T-score < -2.5 |
|---|--------------------|-------------------|--------------------------------|-----------------------------|
| Female students aged up to 25 years old | 133 | 19.5 | 57.9 | 22.6 |
| Female students over 25 years old | 37 | 18.9 | 67.6 | 13.5 |

Group of examined students aged up to 25 presented the following parameters: average body height and body weight of 176.2 ± 6.8 cm and 74.8 ± 11.8 kg respectively. BMI value of this group was normal and amounted to 24.0 ± 3.3 kg/m². A small group of older students, whose average age was 36,6 ± 9,2 was shorter (176.3 ± 6,8 cm) compared to the younger students and heavier by 5,6 kg. Also BMI value in this group was higher and amounted to 25.8 ± 4.6 kg/m², what testified to presence of overweight (table 3).

Table 3. Basic anthropometric parameters of male students

| Age of subjects (years) | Body mass (kg) | Body height (cm) | Body Mass Index kg/m ² | % fat content | Lean body mass |
|-------------------------------|----------------------------|----------------------------|-----------------------------------|-------------------------|--------------------------|
| 20.9±1.4 18 – 24 n - 61 | 74.8±11.8 47.5 – 106.0 | 176.2±6.8 159.2 – 194.1 | 24.0±3.3 18.8 – 32.6 | 18.3±5.1 20.8 – 31.5 | 60.6±8.5 41.4 – 85.4 |
| 36.6±9.2 25 – 47 n - 9 | 80.4±15.2 64.01 – 111.0 | 176.3±6.8 161.4 – 183.4 | 25.8±4.6 19.0 – 33.2 | 22.2±5.3 13.5 – 29.5 | 61.5±10.3 50.4 – 82.7 |

In a group of men aged up to 25 normal bone calcification had 31.1% of them, changes typical of osteopenia revealed 62.3% and characteristic of osteoporosis 6.6% of examined students. Among 9 older students normal bone calcification revealed 55.6% of examined, changes typical of osteopenia were found among 44.4%. Changes in bones calcification testifying to osteoporosis occurrence in this group of subjects were not found (table 4).

Table 4. Bones calcification among male students taking into account age groups (%).

| Bone calcification Group of subjects | Number of subjects | Norm T-score > -1 | Osteopenia -1 > T-score > -2.5 | Osteoporosis T-score < -2.5 |
|---|---------------------------|-----------------------------|---|---------------------------------------|
| Male students up to 25 years old | 61 | 31.1 | 62.3 | 6.6 |
| Male students over 25 years old | 9 | 55.6 | 44.4 | - |

Proper nutrition is one of the ways to prevent development of metabolic diseases such as osteoporosis. Taste is a factor determining most often choice of food and food products. Another place occupy tradition and eating habits, and then health considerations [6]. Proper nutrition is not only a right selection of products and regular consumption of meals, but also such combination of daily menus to take into account all groups of food products. In terms of prevention of osteopenia and osteoporosis it is important to provide the body with adequate supply of calcium with a diet. Carried out among female and male students surveys shown that percentage of people consuming products that are a source of calcium in a diet, was not satisfactory (table 5, 6).

Table 5. Percentage of female students eating products that are source of calcium in a diet

| Food product | Breakfast | Lunch | Afternoon snack | Supper |
|---------------------------------|------------------|--------------|------------------------|---------------|
| Milk soup Aged up to 25 | 10.3 | - | - | - |
| Milk soup Aged over 25 | 12.5 | - | - | - |
| Cottage cheese Aged up to 25 | 21.5 | 16.4 | - | 20.0 |
| Cottage cheese Aged over 25 | 25.0 | 57.1 | 5.0 | 36.4 |
| Hard cheese Aged up to 25 | 25.9 | 27.3 | - | 25.6 |
| Hard cheese Aged over 25 | 18.7 | 14.3 | - | 36.4 |
| Kefir, buttermilk Aged up to 25 | 8.6 | - | - | - |
| Kefir, buttermilk Aged over 25 | 12.5 | - | - | - |

Table 6. Percentage of male students eating products that are source of calcium in a diet

| Food product | Breakfast | Lunch | Afternoon snack | Supper |
|---------------------|------------------|--------------|------------------------|---------------|
| Milk soup | 2.0 | - | - | - |
| Cottage cheese | 5.4 | 5.4 | - | 7.6 |
| Hard cheese | 12.8 | 9.8 | 14.7 | 13.1 |
| Kefir, buttermilk | 3.4 | - | - | - |

Discussion

Prolonged improper nutrition, both in terms of quality and quantity, always leads to certain health disorders. Epidemiological studies carried out in a number of centers in Poland indicate presence of many irregularities in nutrition manner of Polish population, including calcium shortages in a diet [7,8,9]. Calcium consumption in Poland is not satisfactory and does not meet requirements on the safe level in any demographic group[10].

All epidemiological studies carried out in our country in recent years show that diet of Poles do not cover the demand for calcium. Calcium intake by adults is lower than recommended by 20-40%, what may lead to development of skeleton mineralization disorders [11]. Long-lasting negative calcium balance results in disorders of skeleton mineralization, resulting in development of osteopenia and osteoporosis, and later on to increase in fractures incidence. According to definition published by the World Health Organization in 1993, osteoporosis is a systemic metabolic disease of the bone tissue, characterized by low bone mass, impaired micro-architecture

of bone tissue, and consequently increased fragility and susceptibility to fractures. According to the definition, developed in 2001 by experts of the National Osteoporosis Foundation and the National Institute of Health, osteoporosis is a "disease of the skeleton that is characterized by impaired endurance of bone, causing increased risk of fracture." Currently, there are two definitions of osteoporosis, but it is believed today, that the term "risk of fracture" used in the definition of 2001 is the most significant element of this definition [12].

Osteoporosis belongs to a group of diseases in which diet has a huge importance. One of the most important factors, which plays a significant role in prevention of this disorder, is calcium, and in principle size of its supply with food and degree of its absorption in the gastrointestinal tract.

Adequate supply of calcium with a diet is essential for maintenance of bone mineral density in women during premenopausal and postmenopausal periods. It has been found that loss of bone mineral density of the spine was lower among premenopausal women, who increased consumption of dairy products, and thus supply of calcium from 900 mg to 1500 mg per day, compared with those who have not changed their diet [13]. Calcium supplementation allows to reduce loss of bone mass of humeral bone in premenopausal period [14]. In a group of men additional supply of calcium may be important in prevention of bone mass reduction, among persons whose diet is poor in calcium, especially when it is combined with vitamin D supplementation [15]. Results of bone mineralization evaluation obtained in studies of female students from the SHSBP, confirm results of previous studies on bone mineral density carried out among female students of the Main School of Fire Service (SGSP) in Warsaw and Maria Skłodowska-Curie Warsaw College (MSCWC). These studies showed that bone calcification characteristic of osteopenia was found among 38.5% of female students from the MSofS and among 46.8% of examined women from the MSCWC. In addition, 10.1% of female students from the Warsaw College revealed bones calcification characteristic of osteoporosis [16]. Bone mineral density examinations carried out among 79 women studying at the Military University of Technology in Warsaw showed occurrence of disturbances in bones calcification of varying degree of severity. Changes in calcification characteristic of osteopenia were found in 40.5% and of osteoporosis among 38% of subjects [17]. In a group of women living in Warsaw suburbs, aged up to 30 years old, normal bone calcification was found among 19.2% only, a condition characteristic of osteopenia in 68%, and of osteoporosis among 12.8% of examined women [18]. Results of the densitometric examinations of women aged 29.2 ± 3.6 years, doing their military service in the military transport aviation units, shown existence of changes characteristic of osteopenia among 33.3%, and of osteoporosis among 44.5% of examined women [19]. In the studies carried out in a group of 850 female students of physiotherapy, aged 22.1 ± 1.8 years, 19.2% of examined women revealed lowered bone mineral density in distal segment and 50.8% of them in the proximal segment of bones. Authors noted cases of osteopenia occurrence in a distal segment among 25.8% of female students, and in a proximal segment among 61.3% [20].

Group of examined female students of the SHS in Biała Podlaska and cited examination results of women related with military and civilian universities, women living around Warsaw, revealed in large proportion changes in bones mineralization indicating occurrence of both osteopenia and osteoporosis. It seems that changes in skeleton mineralization in young women may be a significant public health issue.

Results of densitometric examinations of different groups of young men also indicate that bone calcification is not satisfactory. Examinations carried out among 203 men beginning compulsory military service shown that 58.6% of them had changes typical of osteopenia and 7.1% typical of osteoporosis [21]. Results of similar surveys conducted among students of the Air Force Academy in Dęblin showed status testifying to occurrence of osteopenia in 41.4% and typical of osteoporosis among 5.7% of students [22]. During examination of 362 men from the Rapid Reaction Force units calcification characteristic of osteopenia was found among 67.2% and typical of osteoporosis among 7.7% of examined soldiers [23]. Better bone calcification revealed students of the Main School of Fire Service. Among 326 young men beginning studies in the years 2009-2012, normal bone calcification revealed 72.7% of them, while 25.8% revealed changes typical of osteopenia and 1.5% changes typical of osteoporosis [24]. Among 120 men from the aircraft crews of the military transport aviation, normal bone calcification revealed 78.2%, 18.8% revealed changes characteristic of osteopenia and 3% changes typical of osteoporosis [19]. 58.1% of students from the Maria Skłodowska - Curie Warsaw College revealed normal bone calcification, while the T-score value typical of osteopenia was found among 38.7% of examined, and values typical of osteoporosis among 3.2% of subjects [25]. Among the full-time and part-time students of physiotherapy studies on the Józef Piłsudski University of Physical Education in Warsaw, 9.8% of them revealed reduced bone mineral density in the distal segment of bones and 39.9% in the proximal segment [20]. Analysis of the results regarding consumption of dairy products, that are the main source of calcium, by students of the SHS, showed that among women cottage cheese was the most popular and was eaten by 51.7% of examined female students. Hard cheese was eaten by $\frac{1}{4}$ of subjects. Among men only 14.7% of them declared consumption of hard cheese, and 7.6% ate cottage cheese. Milk soups and dairy drinks were consumed by much smaller percentage of both female and male students.

Obtained results clearly indicate that the cause of skeleton mineralization disturbances occurring among surveyed students may be insufficient calcium supply resulting from low intake of dairy products.

Correct bone mineralization is conditioned by a diet, and in particular by supply of adequate amount of calcium. On the basis of many studies, including national survey on population health WOBASZ, it was found that the diet of Poles is unbalanced in terms of many components, including calcium. Shortages of calcium intake were found among over 50% of subjects [26]. Nutrition and supply of dietary ingredients essential for bone mineral density is associated with nutritional status and tissue composition of the body, what as the complex of factors has a significant effect on bone tissue. Eating disorders related to insufficient supply of calcium in daily food rations may reduce peak bone mass, which is the main prognostic factor to evaluate risk of osteopenia or osteoporosis occurrence, because skeleton formation process in students has not been fully completed yet.

Conclusions

1. It was found that 80,5% of all examined students revealed abnormalities in skeleton calcification of varying degree of severity. These disturbances occurred more often among younger students i.e. aged up to 25.
2. Dairy products, which are the main source of calcium in daily food rations, were eaten by students quite often. It is necessary to take actions towards practical use of knowledge about osteopenia and osteoporosis prophylaxis, addressed mainly to young people.
3. Taking into account calcium deficiencies occurring in Poland in all age groups, it is necessary to promote proper, rich in calcium, diet, taking into account factors affecting calcium absorption. Students of the SHS in Biała Podlaska should be included in the nutrition education program regarding osteoporosis prevention.

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