

©Borgis

Maja Warzecha^{1,2}, *Edward Czerwiński^{1,3}

Calcium consumption in diet of elderly patients – literature review

Spożycie wapnia z dietą u osób starszych – przegląd literatury

¹Department of Bone and Joint Diseases, Faculty of Health Sciences, Jagiellonian University Medical College, Kraków

Head of Department: Professor Edward Czerwiński, MD, PhD

²Department of Sports Medicine and Human Nutrition, University School of Physical Education in Kraków

Head of Department: Professor Zbigniew Szyguła, MD, PhD

Doctoral Student: Maja Warzecha, MSc

Assistant: Maja Warzecha, MSc

³Kraków Medical Center

Head of Center: Professor Edward Czerwiński, MD, PhD

Keywords

calcium, deficiency, diet, osteoporosis, the elderly

Słowa kluczowe

wapń, niedobory, dieta, osteoporoza, osoby starsze

Conflict of interest

Konflikt interesów

None

Brak konfliktu interesów

Address/adres:

*Edward Czerwiński

Department of Bone and Joint Diseases

Faculty of Health Sciences

Jagiellonian University Medical College

ul. Kopernika 32, 31-501 Kraków

tel. +48 (12) 430-32-09

czerwinski@kcm.pl

Summary

Rational nutrition is particularly important for the elderly or those at risk of osteoporosis. Special attention is paid to an adequate intake of calcium and vitamin D. Deficiencies of these nutrients affect bone loss and can increase the risk of osteoporotic fracture. A literature review was done in order to illustrate the problem of calcium deficiency in the diet of the elderly and of patients who had sustained osteoporotic fractures. The data found in the literature show that the calcium intake is reduced for both the elderly and people with osteoporotic fractures as far as the reference values throughout the world are taken into account. Among the elderly the lowest intake of this element is found among Asians. What is more, in the case of patients who had suffered from osteoporotic fractures the supply of this element in Europe, North America and Asia does not exceed 1000 mg/day, which indicates even greater shortages than in the elderly without fractures. The data indicate the need for patient education in the field of adequate nutrition in case of the treatment and prevention of osteoporosis. Also calcium supplementation must be considered in populations especially exposed to deficiency.

Streszczenie

Dla osób starszych bądź znajdujących się w grupie ryzyka osteoporozy ważne jest racjonalne żywienie. Szczególną uwagę zwraca się na odpowiednią podaż soli wapnia i witaminy D. Niedobory tych składników mają wpływ na utratę masy kostnej i mogą zwiększać ryzyko złamania osteoporotycznego. Dokonano przeglądu literatury celem zobrazowania problemu niedoborów wapnia w diecie u osób w starszym wieku oraz u osób po złamaniach osteoporotycznych. Dane literaturowe dotyczące podaży wapnia z dietą wskazują obniżone wartości spożycia tego pierwiastka względem wartości referencyjnych na całym świecie, zarówno w przypadku osób starszych, jak i u osób po złamaniach osteoporotycznych. Wśród osób starszych najniższe spożycie tego pierwiastka stwierdzono wśród mieszkańców Azji. Natomiast u osób po złamaniach osteoporotycznych podaż tego pierwiastka w Europie, Północnej Ameryce oraz Azji nie przekracza poziomu 1000 mg/dzień, co oznacza jeszcze większe niedobory niż w przypadku osób w starszym wieku bez złamań. Dane te wskazują na potrzebę edukacji pacjentów w zakresie odpowiedniego żywienia w leczeniu i profilaktyce osteoporozy. Warto również rozważyć podjęcie suplementacji diety wapniem w populacjach szczególnie narażonych na niedobory.

INTRODUCTION

Proper nutrition based on an adequate supply of nutrients directly affects health. Improper nutrition, a diet with deficiency or excess of essential nutrients may be one of the factors affecting the development of osteoporosis. Proper nutrition and proper supplementation can delay a number of involuntal changes in the body which

comes with age. Daily consumption of a proper amount of calcium, vitamin D, potassium and magnesium should be particularly stressed in dietary recommendations for the elderly (1). Research conducted among 90 individuals with osteoporosis by Zhao et al. illustrated that the group which was educated about proper nutrition and applied this knowledge showed a significant ($p < 0.05$)

improvement in the results of spine and femoral neck BDM (2). Due to that fact, the appropriate amount of calcium and vitamin D may directly lessen the loss of calcium from bones caused by aging process, reducing the risk of osteoporosis and also reduce the risk of osteoporotic fractures in the case of the elderly (3). The aim of the literature review was to illustrate the problem of not consuming the recommended amount of calcium in the diet of the elderly and people who had suffered from osteoporotic fractures.

EFFECTIVENESS OF THE CALCIUM INTAKE FOR THE ELDERLY

Calcium is one of the basic inorganic constituents present in a human body. The total body calcium is approximately 1-2% of a body weight. The vast majority of total body calcium (> 99%) is located in bone tissue (4). About 30% of the ingested calcium is absorbed in the small intestine; the rest is transformed to the large intestine where another 10% is absorbed. To sum up, 60% of the calcium supplied by everyday diet is excreted in the feces (5). Due to the large loss of calcium, it is important to provide an appropriate supply of this element with the diet or by supplementation if necessary. The effectiveness of calcium supplementation in the case of osteoporotic patients showed positive results in the change of BMD in a group of 1,806 postmenopausal women (2.05% skeletal system in general, 1.66% lumbar spine, 1.6% hip, 1.9% radius) (6). It is increasingly recommended to supplement calcium and vitamin D simultaneously as shown in studies carried out, *inter alia*, by Tang et al. (7). They recommend this pattern of supplementation to postmenopausal women and men over the age of 65 and confirmed the assumption that the supply of 1,200 mg/day of calcium alone or together with vitamin D (800 IU/day), reduces the risk of osteoporotic fractures (7).

RECOMMENDED CALCIUM INTAKE IN A DAILY DIET

Deficiencies of calcium are seen as nutritional risk factors as far as osteoporosis is concerned (8). Recommendations for its consumption, in the case of people over the age of 50, are slightly different for men and women. The recommended dose of calcium for women is 1200 mg/day while men should consume 1000 mg/day. At the age of 70, both groups should provide their organisms with 1200 mg/day (9). The value recommended for different age groups and genders is illustrated below (tab. 1).

It is possible to assess calcium deficiency on the basis of blood serum. It occurs when the amount of calcium is lower than 84 mg/l (normal range 84-104 mg/l) which largely depends on the contents of calcium in a diet, absorption in the gastrointestinal tract, tubular reabsorption and calcium build-up in bones (10).

DEFICIENCIES OF CALCIUM IN THE DIET OF THE ELDERLY PEOPLE

An analysis of data on calcium intake in the diet of the elderly showed its reduced supply against the reference values in most of the analyzed population data in the world (11-22). In Europe, inadequate supply of calcium

Tab. 1. Recommendation of dietary calcium intake (9)

| Age | Male [mg] | Female [mg] | Pregnant [mg] | Lactating [mg] |
|-------------|-----------|-------------|---------------|----------------|
| 0-6 months | 200 | 200 | | |
| 7-12 months | 260 | 260 | | |
| 1-3 years | 700 | 700 | | |
| 4-8 years | 1000 | 1000 | | |
| 9-13 years | 1300 | 1300 | | |
| 14-18 years | 1300 | 1300 | 1300 | 1300 |
| 19-50 years | 1000 | 1000 | 1000 | 1000 |
| 51-70 years | 1000 | 1200 | | |
| > 71 years | 1200 | 1200 | | |

in the diet of men and women has been seen in the UK (823 vs. 1,027 mg/day), Ireland (742 vs. 949 mg/day) and Germany (683 vs. 753 mg/day) (11, 12, 14). In the case of Austria (834 mg/day), the Netherlands (944 mg/day), Poland (862 mg/day) and Slovenia (761 mg/day) daily calcium intake also did not meet the requirements (13, 15-17). Women and men under the age of 60 living in the USA have met the reference values for calcium intake. What is interesting, the amount of consumed calcium decreases with age (while the demand increases) and, in the result, does not reach the proper level (19). After reaching the age of 50 deficiencies are higher in the case of women compared to men. Men in this age group reach the standard (1092 mg/day) in contrast to women (1186 mg/day) (18). An analysis of a group of Americans older than 70 indicates shortages in both sexes (18). The largest differences from the reference supply of calcium in the diet can be observed in the case of Asians (518 mg/day) and Australia (800 mg/day) which may be associated with specificity of local food preferences which reduces the consumption of dairy products (21, 22) (tab. 2).

DEFICIENCIES OF CALCIUM IN THE DIET OF PATIENTS AFTER OSTEOPOROTIC FRACTURES

The supply of calcium from the diet of osteoporotic fracture patients is at an even lower level than in the case of the elderly without fractures. An intake of this element in Europe, North America and Asia do not exceed the level of 1000 mg/day (23-29). The highest average intake of calcium was found in Sweden in the group of patients who had sustained fractures (968 mg/day). Nevertheless, they were still below the recommended value for people over 70 (23). Values below the recommended calcium intake was also found in the case of people with fractures in the Netherlands (790 mg/day) and the USA (730 and 714 mg/day) (24, 25). As in the case of elderly people, Asians are characterized by the lowest level of calcium intake (27-29). In Singapore, the supply of this element in the diet was estimated at the level of 650 mg/day and in Korea – 504 mg/day (27, 28). The lowest daily calcium intake was seen in a group of 481 women in Chi-

Tab. 2. Average intake of calcium in the diet of the elderly

| References | Country | Population | Age [years] | Average calcium intake [mg/day] | Status |
|---------------|--------------------------|------------------------|-----------------|---------------------------------|------------------------------|
| EUROPE | | | | | |
| 11 | Great Britain | Population study | 19-64 | Man 1007 Women 777 | Deficiency Deficiency |
| | | | 50-64 | Man 1027 Women 823 | Normal level Deficiency |
| 12 | Ireland | 662 Man 717 Women | 18-64 | Man 949 Women 742 | Deficiency Deficiency |
| 13 | Austria | 4972 People | – | 834 | Deficiency |
| 14 | Germany | 2006 People | – | Man 753 Women 683 | Deficiency Deficiency |
| 15 | Netherlands | 5958 People | – | 944 | Deficiency |
| 16 | Poland | 88 Women | 67 (average) | 862 | Deficiency |
| 17 | Slovenia | 40 Women | 52 (average) | 761 | Deficiency |
| NORTH AMERICA | | | | | |
| 18 | United States of America | 1439 Man 1350 Women | 31-50 | Man 1220 Women 1055 | Normal level Normal level |
| | | 1215 Man 1251 Women | 51-70 | Man 1092 Women 1186 | Normal level Deficiency |
| | | 808 Man 787 Women | ≥ 71 | Man 1087 Women 1139 | Deficiency Deficiency |
| 19 | United States of America | | 40-59 | Man 1188 Women 882 | Normal level |
| | | | ≥ 60 | Man 966 Women 842 | Deficiency Deficiency |
| 20 | Canada | 3447 Women | 51-70 (average) | 1062 | Deficiency |
| | | 1915 Women | > 71 | 1034 | Deficiency |
| | | 1345 Men | 51-70 | 906 | Deficiency |
| | | 726 Men | > 71 | 884 | Deficiency |
| ASIA | | | | | |
| 21 | Japan | 600 Women | 63 (average) | 518 | Deficiency |
| AUSTRALIA | | | | | |
| 22 | Australia | 794 Men | 81 (average) | 800 | Deficiency |

na (318 mg/day) (29). These data indicate the need to educate patients about an adequate dietary supply of calcium. In addition, calcium supplementation should be introduced in the case of the analyzed population groups, which will inhibit or slow down the process of progressive loss of bone (2) (tab. 3).

Taking everything into account, the data from the literature show that the prevalence of calcium deficiency is common among the elderly and patients who suffered from osteoporotic fractures. It is particularly alarming as far as the direct impact of these components on the functioning of the human skeleton is taken into consideration. The appropriate supply of calcium and vitamin D directly reduces the loss of calcium in the aging process which reduces the risk of not only osteoporosis but also osteoporotic fractures (3). The high prevalence of calcium deficiency is a serious obstacle in the prevention and treatment of osteoporosis. The data from the above-mentioned studies indicate the need for educating the elderly and patients suffering from osteoporosis about the benefits of a properly bal-

anced diet which should include the recommended amount of calcium as illustrated by Zhao et al. (2). In addition, the analysis of the literature allowed to isolate the population vulnerable to shortages of this component which should indicate the need to implement supplementation for people who consume small amounts of dairy products. People suffering from osteoporosis who had a bone fracture, which could be the result of deficiency of calcium or other nutrients in the diet, should be provided with specific recommendations regarding nutrition and supplementation which were included in the studies.

The analysis of the data obtained during these studies shows a high prevalence of calcium deficiency in diet, both in Europe and worldwide. An insufficient supply of this element might be disadvantageous for people with osteoporosis or the elderly at risk. Therefore, due to a high prevalence of calcium deficiency among a certain part of population the monitoring of diet in order to determine the scale of the problem and the possible introduction of supplementation should be performed.

Tab. 3. Average dietary intake of calcium in fractured patients

| References | Country | Population | Age [years] | Average calcium intake [mg/day] | Status |
|---------------|--------------------------|--|--|---|------------|
| EUROPE | | | | | |
| 23 | Sweden | 120 People after fractures | 78 (average) | 968 38% intake < 800 mg/day | Deficiency |
| 24 | Netherlands | 1898 People after fracture | 66 (average) women 65 (average) man | 790 | Deficiency |
| NORTH AMERICA | | | | | |
| 25 | United States of America | 72 337 Women (603 hip fracture) | 65 (average) people after fractures | 730 | Deficiency |
| 26 | United States of America | 9704 Women (1950 non-vertebral fracture, 389 vertebral fracture) | 65 years and more | 714 25% intake < 400 mg/day 41% intake 400-799 mg/day 21% intake 800-1199 mg/day 13% intake > 1200 mg/day | Deficiency |
| ASIA | | | | | |
| 27 | Singapore | 77 People after hip fractures | 60-98 (77.9 average) | 650 7.8% intake > 1000 mg/day | Deficiency |
| 28 | Korea | 277 Women after fracture | 73 (average) | 503.7 | Deficiency |
| 29 | China | 481 Women after vertebral fractures | 75 (average) | 318 | Deficiency |

BIBLIOGRAPHY

- Szcześniak P, Szuszkiewicz J, Michalak Ł, Orszulak-Michalak D: Żywnienie i suplementacja diety w wieku podeszłym. *Farm Pol* 2009; 65(11): 775-779.
- Zhao C, Zhou R, Tian Y et al.: Effects of the nutritional education and dietary intervention on nutritional status and bone mineral density of middle-aged and senile patients with osteoporosis. *Wei Sheng Yan Jiu* 2016; 45(2): 230-235.
- Marcinowska-Suchowierska E, Sawicka A: Calcium and Vitamin D in prevention of osteoporotic fractures. *Post Nauk Med* 2012; 25(3): 273-279.
- Włodarek D: Znaczenie diety w zapobieganiu osteoporozie. *Endokrynologia, Otyłość i Zaburzenia Przemiany Materii* 2009; 5(4): 245-253.
- Flynn A: The role of dietary calcium in bone health. *Proceeding of the Nutritional Society* 2003; 62: 851-858.
- Shea B, Wells G, Cranney A et al.: Osteoporosis Methodology Group, Osteoporosis Research Advisory Group: Calcium supplementation on bone loss in postmenopausal women. *Cochrane Database Syst Rev* 2004; (1): CD004526.
- Tang BM, Eslick GD, Nowson C et al.: Use of calcium or calcium in combination with vitamin D supplementation to prevent fractures of bone in people aged 50 years and older: a meta-analysis. *Lancet* 2007; 370: 657-666.
- Marcinkowska M, Wawrzyniak A, Horst-Sikorska W: Następstwa osteoporotycznego złamania kości. *Prz Menopauz* 2006; 4: 228-230.
- Committee to Review Dietary Reference Intakes for Vitamin D and Calcium, Food and Nutrition Board, Institute of Medicine: *Dietary Intakes for Calcium and Vitamin D*. National Academy Press, Washington, DC 2010.
- Markiewicz-Żukowska R: Stężenie wapnia w surowicy krwi osób starszych. *Bromat Chem Toksykol* 2012; 45(3): 771-774.
- Henderson L, Irving K, Gregory J et al.: *The National Diet and Nutrition Survey: Adults Aged 19-64 Years*. Vitamin and Mineral Intake and Urinary Analytes. The Stationery Office, London 2003: 3.
- IUNA (Irish Universities Nutrition Alliance): *The North/South Ireland Food Consumption Survey – special issue*. *Pub Health Nutr* 2001; 4: 5.
- Koenig J, Elmadfa I: Status of calcium and vitamin D of different population groups in Austria. *Int J Vitam Nutr Res* 2000; 70: 214-220.
- Heseker H, Adolph T, Eberhardt W et al.: *Lebensmittel- und Nährstoffaufnahme Erwachsener in der Bundesrepublik Deutschland 1994 Band III*. VERA-Schriftenreihe. Wiss. Fachverlag Dr. Fleck, Niederkleen.
- Hulshof KFAM, Kruizinga AG: *Third Dutch National Food Consumption Survey (DNFCS-3) 1997-1998*. TNO Zeist 1999, The Netherlands.
- Włodarek D, Sobocińska A, Głabska D: Podaż wapnia z produktów mlecznych w diecie kobiet po 60. roku życia. *Bromat Chem Toksykol* 2012; 45(3): 833-883.
- Kocuvan Mijatov MA, Mičetić-Turk D: Dietary Intake In Adult Female Coeliac Disease Patients In Slovenia. *Zdr Varst* 2016; 55(2): 86-93.
- Bailey RL, Dodd KW, Goldman JA et al.: Estimation of Total Usual Calcium and Vitamin D Intakes in the United States. *J Nutr* 2010; 140(4): 817-822.
- Hoy MK, Goldman JD: Calcium intake of the U.S. population What We Eat in America, NHANES 2009-2010. *Food Surveys Research Group Dietary, Dietary Data Brief* 2014; 13.
- Zhou W, Langsetmo L, Berger C et al.; CaMos Research Group: Longitudinal changes in calcium and vitamin D intakes and relationship to bone mineral density in a prospective population-based study: the Canadian Multicentre Osteoporosis Study (CaMos). *J Musculoskelet Neuronal Interact* 2013; 13(4): 470-479.
- Hirata H, Kitamura K, Saito T et al.: Association between Dietary Intake and Bone Mineral Density in Japanese Postmenopausal Women: The Yokogoshi Cohort Study. *Tohoku Exp Med* 2016; 239: 95-101.
- Waern RV, Cumming RG, Blyth F et al.: Adequacy of nutritional intake among older men living in Sydney, Australia: findings from the Concord Health and Ageing in Men Project (CHAMP). *British Journal of Nutrition* 2015; 114: 812-821.
- Cho K, Cederholm T, Lökk J: Calcium intake in elderly patients with hip fractures *Food & Nutrition Research* 2008; 52: 1-5.
- van den Berg P, van Haard PM, van den Bergh JPW et al.: First Quantification of Calcium Intake from Calcium-Dense Dairy Products in Dutch Fracture Patients (The Delft Cohort Study). *Nutrients* 2014; 6: 2404-2418.
- Feskanich D, Willett WC, Colditz GA: Calcium, vitamin D, milk consumption, and hip fractures: a prospective study among postmenopausal women. *Am J Clin Nutr* 2003; 77(3): 504-511.
- Cumming RG, Cummings SR, Nevitt MC et al.: Calcium Intake and Fracture Risk: Results from the Study of Osteoporotic Fractures. *Am J Epidemiol* 1997; 145: 926-934.
- Lee GH, Lim JW, Park YG, Ha YC: Vitamin D Deficiency Is Highly Concomitant but Not Strong Risk Factor for Mortality in Patients Aged 50 Year and Older with Hip Fracture. *J Bone Metab* 2015; 22(4): 205-209.
- Yoon D, Lee YK, Ha YC, Kim HY: Inadequate Dietary Calcium and Vitamin D Intake in Patients with Osteoporotic Fracture. *J Bone Metab* 2016; 23(2): 55-61.
- Chan HHL, Lau EMC, Woo J et al.: Dietary Calcium Intake, Physical Activity and the Risk of Vertebral Fracture in Chinese. *Osteoporosis Int* 1996; 6: 228-232.

received/otrzymano: 01.09.2016
accepted/zaakceptowano: 22.09.2016