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Assessment of the contribution of calcium and vitamin D in the diet of the elderly

Abstract

Introduction. The rate of aging and the possible coexistence of diet-related diseases are largely determined by the nutrition and lifestyle of the elderly. Therefore, it is important to assess the degree of coverage of organism demand for such nutrients as calcium and vitamin D in the elderly population.

Aim. The aim of the study was to determine the impact of age on calcium and vitamin D supply in daily alimentary rations of the elderly as well as their nutritional behaviour in terms of consumption of products which are the source of these nutrients.

Material and methods. The study involved 42 subjects aged from 60 to 85 years. The vitamin D and calcium content in daily food rations was assessed with the method of a 24-hour dietary interview carried out in triplicate.

Results. The nutrition of the elderly turned out to be inappropriate in terms of supplying the organism with calcium and vitamin D, and this was not age dependent. The average calcium and vitamin D supply in the daily food rations was estimated at 455.53 mg/day and 2.31 μg/day, respectively. The demand for calcium was covered in the range of 31-60% of RDA in over 60% of the elderly and the vitamin D demand was met in 30% of AI in over 80% of the subjects.

Conclusions. The assessment of the daily food rations indicates a necessity for increasing the intake of calcium- and vitamin D-rich food products and dietary supplementation with these components.

Keywords: vitamin D, calcium, sources, demand, the elderly, diet.

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INTRODUCTION

An adequate supply of calcium and vitamin D in the organism is important not only for proper functioning of the skeletal system, organs, and tissues but also for maintenance of calcium-phosphate homeostasis. Population studies indicate substantial calcium and vitamin D deficiencies in virtually every age group of adults. The elderly are particularly vulnerable to the deficiency of these nutrients. This is caused by insufficient exposure to sunlight, limited consumption of nutritional sources of calcium and vitamin D in daily food rations, and changes occurring during the process of aging, which lead to reduced capability of skin synthesis of vitamin D and impaired absorption of these nutrients [1,2]. The widespread calcium and vitamin D deficiency in the elderly population promotes the development of many diseases, e.g. osteoporosis, hypertension, cancer, diabetes, insomnia, or depression. The monitoring of the calcium and vitamin D content in the diet of the elderly may contribute to a slower rate of aging and additionally constitute an element of prevention of diet-related diseases [1-3].

AIM

The aim of the study was to determine the impact of age on the calcium and vitamin D supply in daily food rations of the elderly and their nutritional behaviour associated with the consumption of products that are a source of these nutrients.

MATERIAL AND METHODS

The research involved 42 subjects (37 women and 5 men) in the age range of 60-85, who take part in the activities organised by the Lublin University of the Third Age. The respondents were divided into group I (n=32) consisting of subjects aged between 60 and 74 years and group II (n=10) comprising subjects aged between 75 and 85 years.

The calcium and vitamin D supply in the daily food rations of the elderly was assessed via 166 nutrition-related interviews. The survey was anonymous and voluntary, as emphasised in the questionnaire. The individual food intake was determined with the method of a 24-hour nutritional interview, using a photo album of products and dishes, as recommended by the National Food and Nutrition Institute in Warsaw [4,5]. It lasted for 3 days, i.e. two workdays and one weekend day. Supplementation was taken into account in the calculations. The nutritional value of the daily food rations was calculated in the Dieta 5D program developed at the Food and Nutrition Institute, and the coverage of the nutrition demands was assessed using Polish nutrition standards updated in 2017 [3].

Since a comparison of the calcium and vitamin D levels in an average food ration does not provide a full picture of

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the intake of these ingredients in the entire analysed population, they were analysed in the respective categories, depending on the percentage of coverage of the adopted standards. The following ranges were adopted: 0-30%, 31-60%, 61-90%, 91-110%, and over 111%. The coverage range from 91% to 110% was considered appropriate, as it was in agreement with recommendations.

In the respondent group, the Body Mass Index (BMI) was calculated and the energy and protein nutrition status was determined according to the classification for elderly people. Values <24 kg/m^2 were interpreted as underweight, the range from 24 to 29 kg/m^2 denoted normal body weight, and values ≥30 kg/m^2 indicated overweight or obesity [6].

The results obtained in the 166 correctly completed questionnaires were expressed as percentages within the age groups and as means and standard deviation (SD) or median (Q50). They were statistically analysed using the Statistica version 13.1 computer program. For the quantitative variables, the ANOVA analysis was performed (Fisher or F Welch test) (where the distribution of the results was normal) or non-parametric analysis with the use of the Mann-Whitney U test (where the distribution of the results was not normal), i.e. an equivalent to the classic Student's t-test for unpaired samples, in which the median rather than the mean, as in the case of t tests, is the measure of the central tendency in this test. For the qualitative variables, the analysis was based on Pearson's χ^2 test (Yates correction was applied in justified cases). The value of α=0.05 was assumed as the level of significance (significant differences at $p<0.05$) [7].

RESULTS

The mean BMI value was not statistically differentiated and reached 25.7 kg/m^2 (SD±3.5) in the entire group, 25.9 kg/m^2 (±3.5) in the 60-74 year-old respondents (group I), and 25.1 kg/m^2 (±3.6) in the 75-85 year-old subjects (group II) – ($F=0.42$; $p=0.521$). The evaluation of the nutritional status based on this indicator revealed that 50% of the elderly had normal body weight (24-29 kg/m^2), almost 36% were underweight (<24 kg/m^2), and excessive body weight was found in 14% of the subjects ($\chi^2=0.24$; $p=0.889$). The chi-square test of the BMI ($p>0.05$) categories showed no significant differences between the groups, which indicates that both groups belonged to the same population and were characterised by similar nutritional status of the organism.

The study evaluated the frequency of consumption of selected groups of food products that are a source of calcium or vitamin D. There were no differences between groups I and II in the average frequency of consumption of the selected product groups in daily rations ($p>0.05$) (Table 1). Milk and dairy products were most often consumed in 2 meals per day (45%), but some of the respondents did not eat them at all (14%). Over half of the respondents (62%) consumed meat, eggs, and fish in accordance with the recommendations of proper nutrition for the elderly, i.e. 2 portions of meat, fish, and eggs (e.g. 1 egg, 1 small chicken breast, 1 piece of lean beef, 1 portion of tuna, 6 slices of sirloin). Approximately 31% of the respondents declared that they eat meat, fish, and eggs at least once a day.

It was demonstrated that the daily food rations did not cover the demand for calcium, which is 1200 mg per day in the case of the elderly based on the Recommended Daily Allowances (RDA) [3]. The average supply of the element was estimated

TABLE 1. Frequency of consumption of selected groups of food products by the elderly (% of responses).

Mean daily frequency of consumption in rations	Age categories		Total n=42	Statistics parameters	
	Group I 60-74 years n=32	Group II ≥75 years n=10		χ^2 Pearson test	p value
Milk and dairy products					
0	12.50	20.00	14.28	6.85	0.076
1	46.88	10.00	38.10		
2	40.62	60.00	45.24		
3	0	10.00	2.38		
Meat, fish, eggs					
0	0	10.00	2.38	4.47	0.214
1	34.38	20.00	30.96		
2	62.50	60.00	61.90		
3	3.12	10.00	4.76		

at 455.53 (Q_{50}=449.99) mg/day as well as 475.11 (Q_{50}=468.15) mg/day in group I and 392.88 (Q_{50} = 394.28) mg/day in group II. No statistical differences in the content of calcium in the daily food rations were found between the analysed groups ($F=1.53$; $p=0.223$). The calculated mean percentage of coverage of the demand for this mineral by the daily food rations of the elderly was merely 38% RDA (Figure 1) (Mann-Whitney U test $Z=1.09$; $p=0.275$). The analysis of the percentage ranges of coverage of the recommended calcium intake demonstrated that none of the elderly respondents adequately covered the calcium demand. The largest proportion of the respondents (approx. 64%) were characterised by an intake level of 31-60 % RDA, and almost every third person was supplied with 0-30 % RDA for calcium (Table 2) ($p>0.05$).

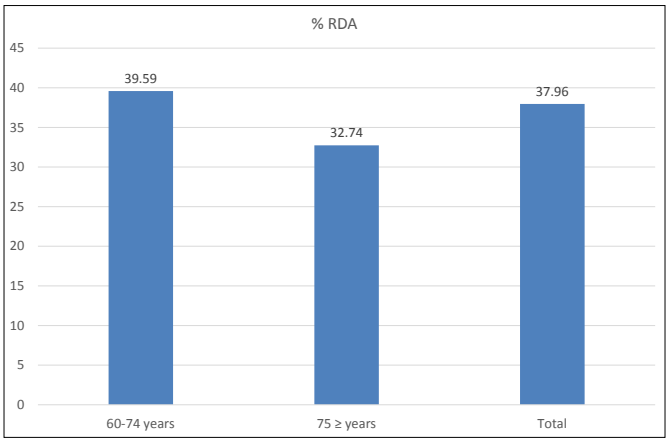

FIGURE 1. Average percentage of calcium requirement coverage compared to the recommended amount (RDA*) for the elderly (*RDA=1200 mg/day, after Jarosz et al. [3]).

TABLE 2. Categories of coverage of calcium demand standards (% of the subjects).

Categories	Age categories		Total n=42	Statistics parameters	
	Group I 60-74 years n=32	Group II ≥75 years n=10		χ^2 Pearson test	p value
0-30%	25.00	40.00	28.57	1.17	0.558
31-60%	68.75	50.00	64.29		
61-90%	6.25	10.00	7.14		

The age of the elderly did not affect the supply of vitamin D in the analysed daily food rations (Mann-Whitney U test, Z=0.768; p=0.443), which was on average 2.31 µg/day (Q_{50}=1.72) in the entire group, 2.55 µg/day (Q_{50}=1.69) in group I, and 1.55 µg/day (Q_{50}=1.83) in group II. The mean percentage of coverage of the demand for this vitamin in the elderly reached merely 15.5 % of the adequate intake (AI) (Figure 2) (p>0.05). The analysis of the percentage ranges of coverage of the recommended vitamin D intake demonstrated that as many as 86% of the elderly respondents supplied vitamin D in the lowest range, i.e. from 0 to 30 % of AI (Table 3) (p>0.05).

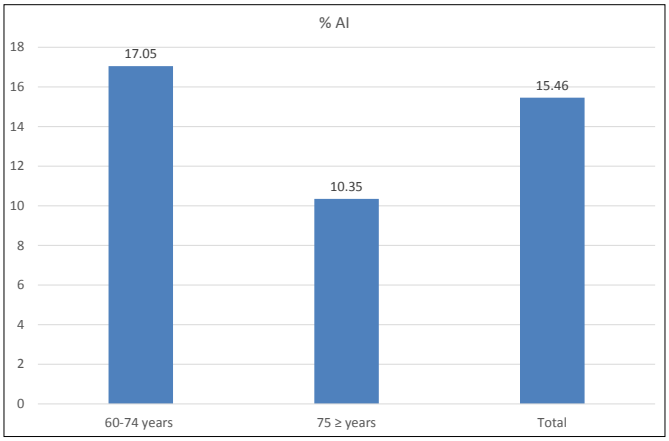

FIGURE 2. Average percentage of vitamin D requirement coverage compared to the recommended intake (AI*) for the elderly (*AI=15 µg/day, after Jarosz et al. [3]).

TABLE 3. Categories of coverage of vitamin D demand standards (% of the subjects).

Categories	Age categories		Total n=42	Statistics parameters	
	Group I 60-74 years n=32	Group II ≥75 years n=10		χ^2 Pearson test	p value
0-30%	81.25	100.00	85.71	2.19	0.335
31-60%	15.63	0.00	11.90		
61-90%	3.13	0.00	2.38		

A vast majority of the elderly respondents (86%) declared that they did not take any dietary supplements and there were no statistically significant differences between the age groups (χ^2=7.70; p=0.260).

DISCUSSION

The low body mass observed in every third elderly person in our studies is particularly alarming, as this age group is characterised by distinctly lower tolerance of malnutrition and a higher risk of mortality associated with this condition, compared with other age groups [6,8].

Calcium is the basic building material of bone tissue. It also stimulates lipolysis, thereby limiting excessive deposition of adipose tissue, which beneficially modifies the composition of body mass. The process of aging is associated with gradual reduction of bone mass, bone susceptibility to fractures, and development of osteoporosis, hence the increased demand for this mineral in the elderly. Additionally, calcium exerts a cardioprotective effect, which is important given the fact that cardiovascular diseases affecting subjects in older age groups are still the primary cause of premature deaths in the Polish population [9]. With age, the demand for calcium increases, which is also related to the reduced intestinal absorption of the element caused by e.g. vitamin D deficiency in the organism. This in turn is associated with reduced hydroxylation of vitamin D in the kidneys, reduced capability of skin synthesis of vitamin D, limitation of time spent in the open air and, consequently, insufficient exposure to UV-B radiation, and reduced intake of vitamin D-rich products and dietary supplements providing vitamin D [10].

The daily calcium demand, which is higher in the elderly than in the middle-aged people, can be easily met by regular consumption of milk and dairy products, which are a source of absorbable calcium [3]. The recommended consumption of milk and dairy products for the elderly is approximately 2-3 portions per day (1 glass of milk or yogurt, kefir, 2 slices of cheese, 2-3 slices of cottage cheese) [3,11]. As shown by the present study, less than 50% of the total number of the elderly consumed the suggested number of portions of these products. Similar unsatisfactory results were reported by Skop-Lewandowska et al. [12], who showed that milk and dairy products (yogurt, kefir, buttermilk, cottage cheese) were consumed by the elderly 2-3 times a week, and 1/3 of respondents consumed milk every day and cottage cheese 2-3 times a week.

Such products as saltwater fish, eggs, and meat are a source of calcium and vitamin D. Saltwater fish are a rich source of vitamin D and polyunsaturated fatty acids from the n-3 family. They are recommended for consumption in many diseases, but are rarely included in menus of the elderly due to the high price and low availability [13]. The present study demonstrated that over 60% of the diets of elderly respondents from the analysed groups followed the recommended frequency of consumption of meat, eggs, and fish, which are a source of calcium and vitamin D.

The present study also showed limited dietary supplementation among the elderly (14%), which may be associated with the insufficient knowledge of the positive effect of an increased supply of essential nutrients via supplementation, especially at an old age, or with the poor financial status. According to the new nutritional guidelines, the elderly are advised to vitamin D supplementation at a dose of 800-2000 IU/d (20-50 µg/day, depending on body weight) due to the deficiency and impaired metabolism of this vitamin in the organism [3].

The present study indicated considerably deficient consumption of calcium and vitamin D by the elderly respondents, regardless of their age. The average calcium and vitamin D supplies were estimated at 455.53 mg/day and 2.31 µg/day, respectively. The demand for calcium was covered in the range of 31-60% of RDA in over 60% of the elderly and the vitamin D demand was met in a mere range of 0-30% of AI in over 80% of the subjects. Results reported by other authors are similar to those obtained in this study, which confirms the prevalence of the problem of the insufficient supply of calcium and vitamin D in the diet of the elderly. The European intake of vitamin D was assessed in a study conducted as part of EPIC (European Prospective Investigation into Cancer and Nutrition). The average daily intake of vitamin D in the European countries was estimated at 4.8 µg/day in males and 3.3 µg/say in females, but there were significant differences in the supply between the countries [14]. As demonstrated by Pasini et al. [15], the vitamin D supply in the diet of elderly Italian residents was similar to the value determined in this study, i.e. 2.2 µg/day. As in the present study, Suliga [16] reported a low percentage of calcium standard compliance in the elderly, i.e. 53.1% in women and 74.8% in men.

CONCLUSIONS

1. The average calcium and vitamin D content in the daily food rations of the elderly was insufficient, regardless of their age, and did not cover the organism demand for these nutrients.
2. The diet of the elderly subjects does not correspond to rational nutrition principles and leads to deficiency of calcium and vitamin D, which may contribute to intensification or development of chronic non-communicable diseases.
3. The vitamin D and calcium deficiencies in the analysed daily food rations for the elderly require an increase in the proportion of calcium- and vitamin D-rich food products in the diet as well as dietary supplementation with these components.

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