Factors Determining Calcium Intake in Elderly Women of Appalachia

ALFRED K. PFISTER, MD, JOHN T. WULU, JR., PhD, and PAUL D. SAVILLE, MD, Charleston, WV

ABSTRACT

Background. Although it has been recommended that women aged 65 and older consume at least 1,500 mg of calcium daily, no studies are available that define the factors associated with adequate intake.

Methods. We studied 184 elderly women to determine the relationship between foodstuff calcium consumption and anthropomorphic measurements and numerous life-style changes.

Results. The mean foodstuff calcium consumption was 563.4 mg/day, with significantly higher intake noted in women who snacked daily, did not skip meals, drank one or more servings of milk daily, and ate yogurt daily. Dietary calcium intake was also dependent on socioeconomic status and personal attitudes toward milk.

Conclusions. All elderly women in this study underachieved the recommended dietary calcium intake of 1,500 mg/day. Widescale public education to promote more positive attitudes among elderly women is crucial. The evidence from this study recommends calcium supplements with vitamin D for virtually all elderly women.

ALTHOUGH a link between foodstuff calcium consumption and fracture rates was established several years ago,[1] it has been only in recent years that considerable attention has been directed toward emphasizing the importance of adequate calcium intake with respect to the diet of elderly women. In 1978, Heaney et al[2] showed through calcium balance studies in perimenopausal women that a minimum of 1,500 mg of calcium daily was needed to achieve at least a nonnegative calcium balance. This finding has not only been advocated by the 1994 Consensus Conference on Calcium, but also caused a change in the 1997 recommended daily allotment.[3,4] Calcium supplements in women reduce the biochemical markers of bone resorption, improve bone mineral density, and diminish fractures.[5-11] During the past 5 years, the introduction of bisphosphonates and nasal calcitonin for the treatment of osteoporosis has further underscored the need for consuming adequate calcium intake.[12,13] A recent meta-analysis of postmenopausal women showed that high calcium intake potentiate the effect of calcitonin and estrogen therapy on bone mass at all skeletal sites.[14]

Elderly adults require relatively higher calcium intake than other subpopulations because of inadequate vitamin D levels, impaired conversion of vitamin D to its active compound in aging kidneys, impaired renal calcium conservation, and reduced intestinal absorption of ingested calcium.[15-17] For the serum calcium to maintain its state of normalcy in the situation of reduced dietary intake, elevated parathyroid hormone levels draw from the bone reservoir.

KEY POINTS

- Elderly adults require relatively higher calcium intake than other subpopulations because of inadequate vitamin D levels, impaired conversion of vitamin D to its active compound in aging kidneys, impaired renal calcium conservation, and reduced intestinal absorption of ingested calcium.
- The inability of elderly women to adequately increase calcium intake to suppress secondary hyperparathyroidism makes it difficult to distinguish age-related bone loss from nutritional bone disease.
- We found a mean dietary calcium intake of 563.4 mg/day, which is far below the recommended value of 1,500 mg/day. No participant in our study achieved the recommended value. This strongly supports the contention of a chronic calcium deficiency syndrome in elderly women.
- A wide-scale public education program, similar to the National Cholesterol Education Program Panel, needs to be adopted. This might shape better attitudes and nutritional knowledge concerning milk and dairy products in the elderly.
- A change in the marketplace strategy of producers and suppliers, intended to improve dairy product consumption, was suggested as a plausible solution.

From the Department of Medicine, Robert C. Byrd Health Sciences Center, West Virginia School of Medicine, Charleston Area Medical Center, and the CAMCARE Health and Research Institute, Charleston, WV.

Reprint requests to Alfred K. Pfister, MD, 4604 MacCorkle Ave SE, Charleston, WV 25304.

This resultant state of secondary hyperparathyroidism may substantially contribute to bone loss in the elderly. Calcium administration can suppress the increased parathyroid hormone levels as well as the biochemical markers of bone resorption back to values observed in premenopausal women.[18] The inability of elderly women to adequately increase calcium intake to suppress secondary hyperparathyroidism makes it difficult to distinguish age-related bone loss from nutritional bone disease. Despite all of these acknowledged benefits of increased calcium consumption to bone loss, calcium intake in the United States remains low, especially in elderly women.[19]

Dairy products remain the main supply of dietary calcium in the United States.[20] Although the level of milk tolerance and social environment were found to be the major determinants of calcium intake in adolescents,[20] all essential factors that affect calcium nutrition in the elderly have yet to be uncovered. Thus, we conducted a study by the 24-hour dietary recall method in a sample of elderly women to test the hypothesis that certain social, personal, economic, and dietary factors influence calcium foodstuff consumption. The goal of this investigation was to identify which factors and dietary items would distinguish elderly women with high calcium intake.

MATERIALS AND METHODS

A sample of 206 women 65 years of age or older from the ambulatory clinics at the Charleston Area Medical Center (CAMC) was given a dietary interview by the 24-hour recall method. Although 237 were approached for interview, 31 subjects declined because of the time required for the process (approximately 45 minutes). Only 184 were able to give adequate information for the final analysis. All subjects were free of chronic diseases that could have affected satiety (eg, chronic renal or respiratory illness, terminal or near-terminal cancer, decompensated congestive heart failure, and cerebral infarction). None of the subjects had had more than a 5-lb weight loss over the past 2 years. All subjects were able to function adequately on a Mini-Mental State Examination. All subjects' visits at the outpatient clinics were for follow-up on their existing medical conditions, such as hypertension, diabetes, anxiety, arthritis, and respiratory illness. Patients who had been given special diets (eg, diabetic, low sodium) were included, since such individuals make up a substantial percentage of the general population in southern West Virginia. To avoid bias when obtaining permission for the interview, the intent was broadly stated as "investigating what type of food people in your age group eat and what influences this choice." Moreover, a questionnaire regarding specific questions about consumption of dairy products was presented after the 24-hour dietary recall inquisition. The study was approved by the CAMC Institutional Review Board.

Instruments

A single 24-hour dietary recall survey was administered to each participant during an outpatient clinic visit. To minimize interviewer bias, the same investigator did all interviews in the survey. Thirty-two of the participants were given both a 24-hour dietary recall survey followed by a 3-day food diary for the purpose of validation. Participants were provided with instructions and a sample sheet on how to produce and record a 3-day food diary. Foodstuff items were recorded according to the individual recalling the contents of breakfast, lunch, and dinner, followed by snacks, food additives, and supplements. Various household measuring instruments (eg, cups, spoons, glasses, bowls) and food models were used to help quantify food portion sizes. Once the participant considered the dietary recall complete, the interviewer then reviewed the list contents to ensure accuracy by looking for errors of omission and quantity. Inquiries about the use of any specific beverages with meals or additives during food preparation were posed to the participants.

A 15-item questionnaire was then administered to investigate the following personal aspects of the participants's household: number of inhabitants; maximum number of diners attending at least one meal a day; whether the subject or another person was responsible for meal preparation; whether the subject or another person was responsible for food shopping; number of meals per week brought into the house from outside sources; number of meals per week consumed outside the home; number of meals skipped per week; and frequency of snacks. Additionally, the number of servings of various calcium-containing food items (eg, processed cheese, cottage cheese, yogurt, pizza, ice cream, and milk) were determined in a semiquantitative manner (one per day, one to five per week, less than one per week). The type of milk (skimmed, ½%, 1%,

TABLE 1. Personal, Socioeconomic, Health, and Dietary Factors Related to Calcium Consumption in Women Aged 65 and Older

Factors	*No. of Subjects*	*Mean (SD)*	P *Value*
Calcium supplement tablets*			
No calcium supplements	130	560.7 (266.5)	NS
Calcium supplements	54	571.1 (267.0)	
Alcohol intake			
No alcohol consumption	162	570.3 (270.7	NS
Regular alcohol consumption	22	515.9 (227.6)	
Type of milk consumed			
Reduced fat content	156	576.1 (260.2)	NS
Whole	27	506.7 (290.0)	
Food shopping responsibility			
Shops for own food	159	559.1 (267.5)	NS
Another person shops for food	29	593.4 (258.1)	
Meal preparation responsibility			
Prepares own meals	165	564.4 (268.9)	NS
Another person prepares meals	19	558.1 (246.0)	
Pizza slice consumption			
Daily or up to five per week	21	479.2 (229.4)	NS
Less than one slice per week	163	574.7 (269.0)	
Socioeconomic level			
Lower	34	488.0 (219.4)	NS
Middle	117	573.4 (268.3)	
Upper	33	607.7 (292.6)	
Milk quantity intake			
One or more servings daily	89	674.9 (265.7)	<.001
One to five servings a week	56	484.2 (233.9)	
Less than one serving a week	39	424.4 (199.4)	
Cheese consumption			
One or more servings daily	23	607.9 (229.1)	NS
One to five servings a week	96	576.8 (263.6)	
Less than one serving a week	65	528.9 (280.9)	
Yogurt consumption			
One or more servings daily	10	754.6 (276.3)	<.001
One to five servings a week	32	703.8 (256.2)	
Less than one serving a week	142	528.8 (251.9)	
Ice cream consumption			
One or more servings daily	5	766.8 (335.2)	NS
One to five servings a week	39	585.2 (286.5)	
Less than one serving a week	140	550.6 (256.3)	
Number of inhabitants			
None	76	530.6 (252.2)	NS
One	91	596.6 (275.2)	
More than one	17	536.1(269.3)	
Number of co-diners			
None	80	535.1 (249.0)	NS
One	91	600.9 (277.7)	
More than one	13	480.5 (262.0)	
Eating outside of home			
Less than once a week	95	568.8 (248.6)	NS
One to seven times a week	84	568.2 (288.5)	
More than seven times a week	8	394.0 (139.0)	
Skipping meals			
Almost never	129	607.4 (264.7)	<.001
One to five times a week	34	499.7 (247.9)	
Almost every day	21	399.2 (223.2)	
Snacks			
Almost never	84	517.9 (241.3)	<.05
At least once a day	62	640.5 (295.3)	
One to five days a week	38	539.9 (245.5)	

*Total amount of calcium intake does not include calcium supplements.

2%, or whole) was recorded. Finally, the questionnaire delved into the participant's personal attitude concerning milk: "I do not like it"; "It causes me to gain weight"; "It causes my blood fats to go up"; "I was told not to drink it"; or "I enjoy milk". The age of onset of milk dislike was noted. All participants had their age, anthropomorphic characteristics, daily alcohol intake, recall day of week, month of year, and the use of calcium supplements recorded. Annual income was used to delineate the socioeconomic class into lower (under $10,000), middle (between $10,000 and $30,000), and upper (more than $30,000). We

TABLE 2. Attitudes of Elderly Women About Milk and Mean Calcium Intake (Milligrams per Day)

	No. of Subjects (%)	*Mean Calcium Consumption (SD)*
I do not like milk	42 (22.8)	468.1 (227.1)
It causes indigestion	22 (12.0)	474.4 (248.8)
It causes me to gain weight	4 (2.2)	550.5 (162.1)
It has too much fat for my blood	5 (2.7)	347.8 (209.0)
I was told not to drink it	3 (1.6)	563.3 (308.7)
I enjoy milk	108 (58.7)	629.7 (270.4)

also recorded diabetes, educational status, and current smoking status of all participants.

Statistical Analysis

The foodstuff contents from all diet records were coded and analyzed on food database software from Food Processor II (1987 ESHA Research, Salem, Ore) to quantify intake of calcium, calories, protein, and fiber. The Student *t* test and one-way analysis of variance were used to determine whether all groups/categories for a given variable have the same mean foodstuff calcium intake. Univariate analysis was done on relevant variables to examine the distribution and characteristics of such variables. Logistic regression analysis was used to model the effects of predictors on dichotomous outcomes or to assist with determining the extent of the relationships among selected variables. Multiple linear regression was applied to show relationship between a selected response variable and explanatory variables. The data were analyzed using the Statistical Analysis System version 7.0 (SAS Institute, Cary, NC). All assumptions pertaining to particular statistical tests were made before applying the tests to the data.

RESULTS

The mean age (± SD) years of the 184 subjects who completed both the 24-hour recall and questionnaire satisfactorily for analysis was 73.8 ± 7. Their highest level of education showed that 47.3% finished high school, and an additional 28.8% finished at least 1 year of college. Additionally, 21.7% were smokers, 14.6% were diabetics, and 13.5% admitted consuming at least one drink of alcohol daily. The validation study of the 32 women who completed both the 24-hour recall and 3-day food diary showed a correlation coefficient of 0.53 ($P < .05$). No significant differences in mean calcium intake were noted among age groups, day of week, and season of the year. Approximately two thirds of the sample were in the middle SES, and more than 70% did not take calcium supplements and did not skip any meals. Eighty-five percent of the women drank reduced-fat milk. The mean foodstuff calcium intake (± SD) was 563.4 ± 266 mg/day. None of the participants achieved the recommended intake of 1,500 mg of calcium per day. Further, only 7.0% of the participants exceeded 1,000 mg of daily calcium intake.

TABLE 3. Multivariate Correlates for Selected Factors Affecting Calcium Intake Among Elderly Women (N = 184)

	All Patients	
Factor/Characteristic	*OR*	*95% CI*
Age group (yr)		
65-69	3.41	(0.98, 12.0)
70-74	1.92	(0.55, 6.70)
75-79	2.80	(0.74, 10.2)
80-84	1.71	(0.38, 7.70)
≥85	1.0	NA
Socioeconomic status		
Low	0.22	(0.07, 0.73)
Middle	0.42	(0.16, 1.05)
High	1.0	NA
Milk consumption		
Low	1.0	NA
Middle	2.37	(0.85, 6.40)
High	9.78	(3.69, 26.0)
Cheese consumption		
Low	1.0	NA
Middle	1.68	(0.83, 8.71)
High	2.69	(0.83, 8.71)
Snacks consumption		
Low	1.05	(0.43, 2.56)
Middle	1.0	NA
High	2.24	(0.87, 5.80)

OR = Odds ratio, CI =confidence interval, NA= not applicable.

Factors Affecting Dietary Calcium Intake

Consuming one or more glasses of milk daily, eating one or more servings of yogurt daily, daily snacking, and not skipping meals were all significantly associated with higher foodstuff calcium intake (Table 1). The mean calcium intake for the subgroup who enjoyed milk (60%) was relatively higher than those who found this beverage less appealing for a variety of reasons (Table 2). This dislike for milk could be historically antedated to childhood in 85% of the women.

Low SES, daily snacking, and consuming one or more servings of milk daily were significant predictors of foodstuff calcium intake among all respondents (Table 3). Although calcium intake generally varied nonsignificantly among age groups, women in the age group of 65 to 69 were 3.4 times more likely to have higher calcium-containing food intake than those aged 85. Participants who drank one or more servings of milk daily were almost 10 times more likely to have higher calcium

TABLE 4. Multivariate Correlates of Selected Factors Affecting Calcium Intake Among Women 65 to 74 Years Old and Those ≥75 Years Old

	Age 65 to 74 (n = 108)		*Age ≥75 (n = 76)*	
Factor/Characteristic	*OR*	*95% CI*	*OR*	*95% CI*
Age (yr)				
65-74	2.15	(0.85, 5.45)	NA	NA
70-74	1.0	NA	NA	NA
75-79	NA	NA	0.28	(0.04, 2.00)
80-84	NA	NA	1.45	(0.31, 7.13)
≥85	NA	NA	1.0	NA
Socioeconomic status				
Low	0.14	(0.03, 0.80)	0.28	(0.04, 2.00)
Middle	0.24	(0.06, 1.03)	0.53	(0.13, 2.14)
High	1.0	NA	1.0	NA
Milk consumption				
Low	1.0	NA	1.0	NA
Middle	1.82	(0.51, 6.57)	5.20	(0.84, 32.3)
High	14.4	(3.55, 58.1)	10.1	(1.92, 53.6)
Cheese consumption				
Low	1.0	NA	1.0	NA
Middle	3.85	(1.21, 12.3)	0.72	(0.20, 2.59)
High	8.47	(1.47, 48.8)	0.97	(0.15, 6.20)
Snacks consumption				
Low	0.66	(0.19, 2.28)	1.56	(0.38, 6.34)
Middle	1.0	NA	1.0	NA
High	1.11	(0.30, 4.08)	6.58	(1.38, 31.5)

OR = Odds ratio, CI =confidence interval, NA = not applicable.

intake than those who were low milk consumers. A similar relationship was even more significant in participants aged 65 to 74 (OR = 14.4; 95% CI, 3.6 to 58.1) (Table 4). Additionally, participants of low or middle SES were 80% and 60% respectively, less likely to have higher calcium intake than those of high SES. Higher calcium intakes were observed in participants with the characteristics of eating one or more servings of cheese daily (OR = 2.6; 95% CI, 0.8 to 8.7) but was significantly greater only in women aged 65 to 74 (OR = 8.5; 95% CI, 1.5 to 48.8). Daily snackers in this study showed higher calcium intake than their counterparts, but this difference became significant only in the older group of women aged ≥75 (OR = 6.6; 95% CI, 1.4 to 31.5).

The correlation matrix of selected variables (eg, calories, body mass index [BMI], dietary fiber, and age) showed the foodstuff calcium intake to be significantly correlated with calories ($r = 0.41$, $P < .05$) and dietary fiber ($r = 0.17$, $P < .05$), but not with age or BMI. This correlation between calories and calcium intake was highly significant in the group aged 65 to 74 ($r = 0.50$, $P < .01$). A 1-unit change in calories yielded a 25% change in the average value of calcium intake in all patients, but a 33% change in the average calcium intake in the age group 65 to 74. A multiple regression model showed that 17% of the variation of calcium intake could be explained by the predictor variables (BMI, age, calories, fiber, and SES) in the entire cohort but accounted for 29% of the variance in the younger age group of 65 to 74.

DISCUSSION

We found a mean dietary calcium intake of 563.4 mg/day, which is far below the recommended value of 1,500 mg/day. No participant in our study achieved the recommended value. This strongly supports the contention of a chronic calcium deficiency syndrome in elderly women. The mean dietary calcium intake obtained in this study by the 24-hour dietary recall survey, a method used widely in the United States, is slightly lower than that of the recent NHANES III study, but similar to the results of a 24-hour recall conducted by telephone in Kansas.[19,21] In this study, we found that the factors that identified individuals with higher calcium intake (daily milk drinkers, yogurt eaters, daily snackers, and individuals who do not skip meals nor dislike milk) may not necessarily be helpful in defining adequate calcium intake.

One third of the study participants were either intolerant to or disliked milk. These participants could be counseled to enrich their diet with alternative calcium-containing foods. However, it is unrealistic to think that such an approach would be cost effective or even practical when applied on a large scale basis in the community. Compliance also may be an issue in this situation. A group of elderly women who were given milk powder supplements to bolster their intake above 1,500 mg/day relapsed to baseline values 2 years after the study was completed.[22] It would appear that calcium and vitamin D supplements would be more practical in lactophobic individuals.

The remaining two thirds of the study participants enjoyed drinking milk. The correction of chronic calcium deficiency would appear to be easily accomplished by an increased consumption of four glasses of low-fat milk daily or a combination of dairy products. This approach appears to be simple but cannot be achieved or addressed by health care professionals alone. It seems that a wide-scale public education program, similar to the National Cholesterol Education Program Panel, needs to be adopted. This might shape better attitudes and nutritional knowledge concerning milk and dairy products in the elderly.

Low SES was a significant predictor of low calcium intake in this study. Nutritional knowledge is strongly correlated with SES.[23] Although both the socioeconomic group and nutritional knowledge play a prominent role in food choices and elderly dietary practices, the important factors that intervene with these two variables are nutritional attitudes and beliefs.[23-25] The importance of promoting a positive nutritional attitude is emphasized in an editorial by Heaney,[26] who states that approximately one third of osteoporotic sequelae have an underlying nutritional basis. A change in the marketplace strategy of producers and suppliers, intended to improve dairy product consumption, was suggested as a plausible solution. This should shift the mean dietary consumption of calcium intake of the entire population. Until such an event designed to mold public attitudes and beliefs occurs, adequate dietary calcium intake in the population cannot happen. Therefore, it is strategic to recommend the concept that virtually all elderly women should receive calcium and vitamin D supplementation. It is unfortunate that this approach omits the concomitant nutrients and the high calcium-protein ratio present in milk and other dairy products.[27,28]

Daily snacking was associated with significantly higher calcium intake in the women aged 75 and older when compared with the women aged 65 to 74. Since elderly individuals often obtain calcium from only a few items in their diet, it would seem that cheese consumption would be an important snack item in groups who snack more frequently.[29] However, the data analyzed in this study did not confirm that belief.

Overall, foodsuff calcium intake correlated significantly with calories but weakly with the BMI. This observation in elderly individuals probably results from low physical activity.[30] The low correlation of calcium intake with dietary fiber deserves attention, since diets higher in various fiber components impair the absorption of calcium and may thereby accelerate nutritional bone disease in the elderly.[31-33] However, only 16% of the study participants who consumed less than 600 mg of dietary calcium per day ate 20 grams or more of fiber daily.

CONCLUSIONS

In this study, dietary calcium intake was highly dependent on personal attitudes toward milk, drinking one or more servings of milk daily, and yogurt consumption, but not toward other dairy products (cheese, ice cream, or pizza). Low SES was highly predictive of low calcium intake. Women who skipped meals had significantly lower calcium intake, whereas those who snacked daily had significantly higher intake.

Although these findings are helpful in guiding health care professionals to screen the elderly and provide them with simple dietary advice to boost their calcium intake to the recommended level, time constraints and the prevailing public attitudes about milk may make this difficult. In light of these considerations, this study recommends that almost all elderly women receive calcium and vitamin D supplementation to achieve the recommended daily calcium intake. Future studies of elderly women in the United States should be directed toward determining the levels of acceptance and palatability of the various calcium and vitamin D preparations, as well as long-term compliance with their use.

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No man is an island entire of itself. Every man is a piece of the continent, a part of the main.

John Donne
Meditation 17