0021-972X/06/$15.00/0
Printed in U.S.A.

The Journal of Clinical Endocrinology & Metabolism 91(8):2980–2985

doi: 10.1210/jc.2006-0510

Vitamin D Status in Relation to One-Year Risk of Recurrent Falling in Older Men and Women

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Background: Falls frequently occur in the elderly and are a major cause of morbidity and mortality.

Objective: The objective of the study was to prospectively investigate the association between serum 25-hydroxyvitamin D [25(OH)D] levels and risk of recurrent falling in older men and women.

Design: This was a prospective cohort study.

Setting: An age- and sex-stratified random sample of the Dutch older population was determined.

Subjects: Subjects included 1231 men and women (aged 65 yr and older) participating in the Longitudinal Aging Study Amsterdam.

Measurements: Baseline serum 25(OH)D was determined by a competitive protein binding assay. During 1 yr, falls were prospectively recorded by means of a fall calendar.

Results: Low 25(OH)D (<10 ng/ml) was associated with an increased risk of falling. After adjustment for age, sex, education level, region, season, physical activity, smoking, and alcohol intake, the odds ratios (95% confidence interval) were 1.78 (1.06–2.99) for subjects who experienced two falls or more as compared with those who did not fall or fell once and 2.23 (1.17–4.25) for subjects who fell three or more times as compared with those who fell two times or less. There was a statistically significant effect modification by age, and stratified analyses (<75 and ≥ 75 yr) showed that the associations were particularly strong in the younger age group; the odds ratios (95% confidence interval) were 5.21 (2.03–13.40) for two falls or more and 4.96 (1.52–16.23) for three falls or more.

Conclusions: Poor vitamin D status is independently associated with an increased risk of falling in the elderly, particularly in those aged 65–75 yr. ***(J Clin Endocrinol Metab* 91: 2980–2985, 2006)**

FALLS FREQUENTLY OCCUR in the elderly and are a major cause of morbidity and mortality. About 30% of community-dwelling persons older than 65 yr experience one or more falls every year, and 15% experience two or more falls (1–4). Fall-related injuries are the third leading cause of years lived with disability in the world according to the World Health Organization (5). Falls can result in serious injuries, such as fractures and head trauma (6, 7). Even if a fall does not result in physical injury, a fall might have serious social or psychological consequences, such as fear of falling leading to restrictions in activity or increased dependence (8, 9).

About 5% of falls results in a fracture (1, 7), and more than 90% of the hip fractures are attributable to falls (10). A modest protective effect of vitamin D and calcium supplementation on hip fracture risk has been found and primarily been attributed to effects on bone health (11, 12). However, low serum 25-hydroxyvitamin D [25(OH)D] levels are also related to lower muscle strength (13, 14), loss of muscle strength and muscle mass (15), and increased disability and frailty in older men and women (14, 16). Therefore, vitamin D deficiency may also increase the risk of falling. The prevalence of vitamin D insufficiency was very high in a falls clinic population (17). A metaanalysis of supplementation studies with vitamin D metabolites in elderly persons showed a decrease of the incidence of falls (18). However, the five studies included in this metaanalysis were relatively small and mainly included women. In addition, usually a combination of vitamin D metabolites and calcium was given instead of vitamin D alone. Finally, a part of the studies was performed in institutionalized persons or in subjects who had a low vitamin D status at baseline. All together, the importance of vitamin D for the risk of falls in a general elderly population remains unclear.

The aim of the present study was to investigate the association between serum 25(OH)D levels and the subsequent risk of falls in a cohort of older men and women and examine whether this association is independent of potential confounders.

Subjects and Methods

Study sample

The study was conducted within the Longitudinal Aging Study Amsterdam (LASA). LASA is an ongoing cohort study on predictors and consequences of changes in autonomy and well-being in an aging pop-

First Published Online May 9, 2006

Abbreviations: BMI, Body mass index; CI, confidence interval; 25(OH)D, 25-hydroxyvitamin D; LASA, Longitudinal Aging Study Amsterdam; OR, odds ratio.

JCEM is published monthly by The Endocrine Society (http://www.endo-society.org), the foremost professional society serving the endocrine community.

ulation in The Netherlands. The sampling and data collection procedures have been described in detail elsewhere (19). Briefly, a random sample of older men and women (aged 55–85 yr), stratified by age, sex, urbanization, and expected 5-yr mortality, was drawn from the population registers of 11 municipalities in the areas in the west (Amsterdam and its vicinity), northeast (Zwolle and vicinity), and south (Oss and vicinity) of The Netherlands. In total, 3107 subjects participated in this baseline examination (1992–1993).

The present study included participants who were born in or before 1930 (aged 65 yr and older as of January 1, 1996) and participated in a follow-up examination, which took place in 1995–1996. After a main interview and a medical interview at home (n = 1509), participants were invited to the Vrije Universiteit Medical Center (respondents living in Amsterdam) or a health care center (respondents living in Zwolle or Oss), at which blood samples were obtained. Subjects with missing data on serum PTH, serum 25(OH)D, lifestyle (smoking, alcohol, physical activity), education level, body mass index (BMI), serum creatinine, and three or four periods (of 3 months) of fall follow-up (see below) were excluded. Therefore, our final study sample consisted of 1231 subjects.

All interviews were conducted by intensively trained and supervised interviewers and were tape-recorded to monitor the quality of the data. Informed consent was obtained from all respondents. The study was approved by the Medical Ethics Committee of the Vrije Universiteit Medical Center.

Assessment of falls

The respondents were asked to report their falls weekly on a fall calendar and mail the calendar page to the research center at the end of every 3 months. Respondents were contacted by telephone if they were unable to complete the fall calendar, the fall calendar was not returned even after a reminder, or it was completed incorrectly. Proxies were contacted if participants were not able to respond. These were persons from the same households as the participant or someone from the nursing staff if the participant was institutionalized (n = 33; 2.7%). A fall was defined as an unintentional change in position resulting in coming to rest at a lower level or on the ground (20). Those who fall can be divided into those who have not fallen or those who fell once (most likely coincidental falls with extrinsic cause) and those who fall recurrently (two or more falls during the study period, more likely associated with an intrinsic cause) (3, 21). Therefore, recurrent falls are probably more clinically relevant and therefore were considered as outcome in the present study.

Vitamin D status

Blood samples were obtained in the morning and immediately centrifuged and frozen. Subjects were allowed to have tea and toast but no dairy products. The serum samples were stored at −20 C. PTH was measured by means of immunoradiometric assay (Incstar Corp., Stillwater, MN), and serum 25(OH)D was determined according to a competitive protein binding assay (Nichols Diagnostics, San Juan Capistrano, CA). The interassay coefficients of variation were 12 and 10%, respectively. The analyses were carried out at the Endocrine Laboratory of the Vrije Universiteit Medical Center.

Potential confounders and effect modifiers

Age, sex, region, season, education level, lifestyle variables, weight, BMI, number of chronic diseases, and serum creatinine level were considered as potential confounders because these variables might be associated with both vitamin D status and risk of falling. Four season periods during the year were distinguished: January to March, April to June, July to September, and October to December. Level of education was assessed by asking the respondent for the highest educational level completed, ranging from primary school to university. High education was defined as more than 10 years of education. Lifestyle variables included smoking status, alcohol use, and level of physical activity. The level of physical activity (minutes per day) was estimated by a validated interview-administered questionnaire for older persons (22), covering household activities, sports, walking outdoors, and bicycling during the previous 2 wk. Smoking status was classified as smoker or nonsmoker (cigarettes, cigar, and pipe), and alcohol use was classified as light, moderate, excessive, and very excessive, based on the alcohol consumption index of Garretsen (23). Body weight (kilograms) was measured in subjects wearing underwear only, using a calibrated balance beam scale. Height (meters) was measured using a stadiometer. BMI was calculated by weight divided by height squared (kilograms per square meter). The presence of chronic diseases was assessed with a detailed questionnaire that included chronic obstructive pulmonary disease, cardiovascular disease, stroke, peripheral arterial disease, diabetes mellitus, malignant neoplasms, and joint disorders including osteoarthritis and rheumatoid arthritis (24). Because mild renal impairment could affect vitamin D homeostasis, we also adjusted for serum creatinine levels (determined by routine laboratory method; coefficient of variation 3%). Age, sex, and season were considered as potential effect modifiers for the association between vitamin D status and risk of falls.

Potential mediator

Physical performance was considered as a potential mediator in the association between vitamin D status and risk of falling. Physical performance was assessed by three tests including the walking test (time needed to walk 3 m, turn around 180 degrees, and walk back), the chair stands (time needed to stand up and sit down five times with arms folded), and the tandem stand (ability to stand with one foot behind the other in straight line for at least 10 sec). For the walking test and chair stands, 1 to 4 points were given corresponding to the quartile of the distribution of time needed. The more time that was needed, the lower the physical performance scores. Subjects who did not complete the test were given a score of 0. For the tandem stand, 0 point were given to those who could not perform the tandem stand, 1 point to those who stood 3–9 sec, and 2 points to those who stood at least 10 sec. The three items were summed up to a final score ranging from 0 to 10 points.

Statistical analyses

Baseline characteristics of the population are shown stratified for the number of falls, and differences between the groups were tested by Student's t test for normally distributed variables and by Mann-Whitney's test for variables with a skewed distribution. Differences in proportions were tested by the χ^2 test.

To explore the best cut-off value for serum 25(OH)D levels regarding the risk of falls, several cut points were selected (8, 10, 12, 20, and 30 ng/ml), and the percentage of fallers was compared among all these groups (univariate association). These analyses revealed that 10 ng/ml was the optimal cut-off value. Logistic regression analyses were then performed to study the association between low (<10 ng/ml) serum 25(OH)D (independent variable) and the incidence of falls (dependent variable). Results are expressed as odds ratios (ORs) with a 95% confidence interval (CI). The influence of possible confounders was examined by adding these variables to the regression model. Possible effect modification by age, sex, and season was evaluated by adding product terms [serum 25(OH)D * age, serum 25(OH)D * sex, and serum 25(OH)D * season] to the regression models. Because the effect modification by age was statistically significant ($P < 0.05$), results of the logistic regression analyses were also performed stratified for the rounded median of age (age < 75 and ≥ 75 yr).

To examine whether physical performance could be a mediator in the relationship between serum 25(OH)D and the incidence of falls, first the associations between physical performance and serum 25(OH)D and between physical performance and incidence of falls were investigated. In addition, the impact of adjusting for the potential mediator on the association between serum 25(OH)D and incidence of falls was examined.

The proportion of recurrent falls among the population attributable to low serum 25(OH)D levels (population-attributable fraction) was calculated as: $\text{PAF} = p\ (\text{OR} - 1)/[p\ (\text{OR} - 1) + 1]$, with p being the proportion of subjects having a low serum 25(OH)D level, and OR the corresponding odds ratio adjusted for potential confounders. All statistical analyses were performed using SPSS for Windows (version 11.5.0; SPSS Inc., Chicago, IL).

Results

The baseline characteristics, stratified for the number of falls, are shown in Table 1. Because of the low number of

TABLE 1. Baseline characteristics stratified for number of falls during 1 yr of follow-up (non- and once fallers *vs.* more-than-twice fallers, and non-, once, and twice fallers *vs.* more-than-twice fallers)

	0–1 falls	≥2 falls	*P*	0–2 falls	≥3 falls	*P*
n	1089	142		1159	72	
Age (yr)	75.2 ± 6.4	76.6 ± 6.9	0.014	75.3 ± 6.5	76.9 ± 6.8	0.043
Gender (% male)	49.0	47.9	0.797	48.8	50.0	0.848
Serum 25(OH)D (ng/ml)	21.7 ± 9.5	20.8 ± 10.8	0.342	21.7 ± 9.7	19.5 ± 9.8	0.053
Low (<10 ng/ml) 25(OH)D (%)	9.5	17.6	0.003	9.7	22.5	0.001
Region						
Amsterdam	45.7	51.4	0.231	45.6	58.3	0.050
Zwolle	31.6	24.6		30.9	29.2	
Oss	22.7	23.9		23.5	12.5	
Education (yr; range 0–18)	8.9 ± 3.3	9.2 ± 3.6	0.274	8.9 ± 3.3	9.1 ± 3.7	0.745
High education (%)	27.2	32.4	0.192	27.7	29.2	0.787
Season						
January to March	26.6	23.2	0.495	26.3	25.0	0.494
April to June	28.0	24.6		28.0	20.8	
July to September	16.7	18.3		16.7	19.4	
October to December	28.7	33.8		28.9	34.7	
Smoking (% yes)	17.8	16.9	0.789	17.9	15.3	0.578
Alcohol intake (%)						
No	23.6	28.2	0.714	23.6	33.3	0.082
Light	50.9	45.1		50.3	48.6	
Moderate	19.7	19.0		20.0	12.5	
(Very) excessive	5.8	7.7		6.1	5.6	
Physical activity (min/d)	151.3 ± 95.6	129.2 ± 96.8	0.010	150.5 ± 95.7	120.5 ± 96.2	0.010
PTH (pg/ml)	30.0 (23.3–40.5)	32.1 (24.8–41.7)	0.351	30.1 (23.4–40.7)	32.5 (25.4–41.9)	0.359
BMI (kg/m^2)	26.9 ± 4.2	26.3 ± 4.1	0.105	26.9 ± 4.17	26.6 ± 3.9	0.576
Weight (kg)	74.7 ± 12.7	72.2 ± 12.4	0.024	74.6 ± 12.7	72.8 ± 13.3	0.260
Serum creatinine (mg/dl)	1.14 ± 0.40	1.12 ± 0.24	0.571	1.14 ± 0.39	1.09 ± 0.24	0.321
No. of chronic diseases	1.2 ± 1.0	1.3 ± 1.1	0.205	1.2 ± 1.0	1.4 ± 1.3	0.270
Chronic diseases (% yes)	71.9	73.9	0.610	72.1	72.2	0.987
Physical performance (range 0–10; n = 1210)	6.1 ± 2.5	5.1 ± 2.8	0.000	6.1 ± 2.5	4.7 ± 2.8	0.000

To convert to SI units, multiply by 2.496 for 25(OH)D (nanomoles per liter), 0.105 for PTH (picomoles per liter), and 83.3 for serum creatinine (micromoles per liter).

participants who fell four times or more, characteristics are not shown stratified for zero to three falls *vs.* four falls or more. Subjects who fell more often were significantly older, and the prevalence of low serum 25(OH)D levels (<10 ng/ml) was higher. They also were less active and performed worse at the performance tests. Regardless of the number of falls, PTH levels were 39.7 (31.0–57.8) and 29.1 (22.9–39.0) pg/ml in the low (<10 ng/ml) *vs.* high (≥10 ng/ml) serum 25(OH)D group, which was significantly different ($P < 0.001$). Blood calcium levels were determined in only 382 persons (Zwolle subgroup) of the 1231 subjects who were included in our analyses. Within this subgroup, calcium levels were 9.24 ± 0.56 and 9.28 ± 0.36 mg/dl in the low (n = 28) and high (n = 351) serum 25(OH)D groups, respectively, which was not statistically significantly different ($P = 0.759$).

Within 1 yr of follow-up, 405 subjects (32.9%) fell at least one time, and 142 (11.5%) fell more than once. Table 2 shows the univariate association between the level of serum 25(OH)D and the percentage of fallers, within categories of serum 25(OH)D. The risk of falling was particularly increased when serum 25(OH)D levels were less than 10 ng/ml, whereas there was no difference in risk of falls between groups with levels of 10–20, 20–30, or more than 30 ng/ml. Therefore, these three categories were combined in further analyses. Shifting the cut point of 10 ng/ml to a slightly lower value (8 ng/ml) or slightly higher value (12 ng/ml) did not lead to a better contrast between the low and high serum 25(OH)D categories (data not shown).

Low vitamin D status (<10 ng/ml) was significantly associated with risk of falling two or more and three or more times in 1 yr, also after adjustment for potential confounders (Table 3). There was no significant effect modification by gender ($P = 0.786$ for two or more falls and $P = 0.490$ for three or more falls), but a significant effect modification by age was observed for the risk of two or more falls ($P = 0.027$), and this was borderline significant for the risk of three or more or

TABLE 2. Percentage (%) of fallers in 1 yr of follow-up within categories of serum 25(OH)D

No. of falls	Serum 25(OH)D				
	<10 ng/ml (n = 128)	10–20 ng/ml (n = 456)	20–30 ng/ml (n = 422)	>30 ng/ml (n = 225)	All categories together (n = 1231)
≥1 (n = 405)	38.3	32.0	30.3	36.4	32.9
≥2 (n = 142)	19.5	10.5	9.7	12.4	11.5
≥3 (n = 72)	12.5	5.0	5.5	4.4	5.8
≥4 (n = 32)	7.0	2.4	1.7	2.2	2.6

To convert to SI units, multiply serum 25(OH)D by 2.496 (nanomoles per liter).

TABLE 3. Risk (OR with 95% CI) of two or more falls and three or more falls during 1 yr of follow-up associated with low vitamin D status [serum 25(OH) D < 10 ng/ml]

Model	≥2 falls (11.5%; 142/1231)		≥3 falls (5.8%; 72/1231)	
	OR	95% CI	OR	95% CI
1	2.05	1.27–3.30	2.67	1.84–4.81
2	1.80	1.09–2.97	2.42	1.30–4.50
3	1.80	1.08–3.00	2.29	1.21–4.31
4	1.78	1.06–2.99	2.23	1.17–4.25

Model 1: unadjusted; model 2: model 1 adjusted for age and sex; model 3: model 2 further adjusted for education level, region, and season; model 4: model 3 further adjusted for physical activity, smoking and alcohol intake. To convert to SI units, multiply serum 25(OH)D by 2.496 (nanomoles per liter).

more falls ($P = 0.098$). Therefore, the analyses were also performed with stratification by age, according to the rounded median of age (Table 4). The risk associated with low serum 25(OH)D status was strong and statistically significant in participants younger than 75 yr old but not statistically significant in the older age group. There was no statistically significant effect modification by season. Stratification for season showed that in both seasons the associations with risk of two or more and three or more falls were stronger in younger subjects as compared with older subjects (data not shown).

Additional adjustment for the potential confounders BMI or body weight, serum creatinine, PTH, or chronic diseases did not materially change the results (results not shown). Physical performance was associated with both the risk of falling (Table 1) and 25(OH)D [mean physical performance scores in the low and high serum 25(OH)D group were 4.01 ± 2.32 and 6.24 ± 2.44 ($P < 0.001$), respectively]. In addition, adjustments for the potential mediator physical performance substantially reduced the ORs to 1.53 (0.89–2.62) for two or more falls and 1.80 (0.91–3.55) for three or more falls. Also in the younger age groups only, the ORs were significantly reduced after adjustment for physical performance, although it was still statistically significant for the risk of two or more falls: the OR was 4.21 (1.49–11.91). For three or more falls, the OR was reduced to 3.62 (0.92–14.22).

The proportion of recurrent falls attributable to serum 25(OH)D levels less than 10 ng/ml was 7.5% for two or more falls and 11.3% for three or more falls in the total study sample. Among the participants aged younger than 75 yr, the proportions were 15.3 and 14.5%, respectively, whereas the proportions were 3.8 and 9.3% among participants aged 75 yr or older.

Discussion

The results of the present study show that a poor vitamin D status [serum 25(OH)D < 10 ng/ml] is independently associated with an increased risk of recurrent falling in an older population (aged ≥65 yr). The associations were particularly strong in the relatively young participants (aged < 75 yr) as compared with the older participants (aged ≥ 75 yr). Additional adjustment for the level of physical performance weakened the associations, which indicates that the association between vitamin D and risk of falling may partly be mediated by physical performance.

Previous studies have shown that impairment of gait, postural balance, and muscle strength are associated with risk of falling (1, 25–27) and that a low serum 25(OH)D was independently associated with lower neuromuscular performance in our LASA population (28). Moreover, poor vitamin D status was also related to lower muscle strength (13, 14), loss of muscle strength and muscle mass (15), and increased disability and frailty in older men and women (14, 16). In the present study, low physical performance was associated with low serum 25(OH)D and recurrent falling, and the association between serum 25(OH)D and recurrent falling was partly mediated by physical performance. This suggests that a poor vitamin D status plays a role in the risk of falling in the elderly through an effect on muscle function. The active vitamin D metabolite 1,25-dihydroxyvitamin D plays an important role in the regulation of calcium transport and protein synthesis in the muscle cell. It increases the calcium pool, which is essential for muscle contraction (29).

It is of interest that the association between vitamin D and recurrent falling seems to be limited to the vitamin D deficiency range (<10 ng/ml). We did not observe substantial differences in risk between the 10–20, 20–30, and greater than 30-ng/ml categories of serum 25(OH)D. A stronger association between vitamin D status and falls could intuitively be expected in the oldest subjects because of the higher prevalence of vitamin D deficiency and the increasing incidence of falls with aging. The opposite, however, was found in the present study. It could be argued that at very old age, other risk factors for falling, such as mobility limitations, comorbidity, frailty, or use of psychotropic drugs, may become more important. However, a substantial association in the relatively older group cannot be excluded. The subjects

TABLE 4. Risk (OR with 95% CI) of two or more falls and three or more falls during 1 yr of follow-up associated with low vitamin D status [serum 25(OH)D < 10 ng/ml], stratified for age

Model	≥2 falls				≥3 falls			
	<75 yr		≥75 yr		<75 yr		≥75 yr	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
1	4.41	1.84–10.57	1.37	0.77–2.46	5.67	1.97–16.32	1.75	0.85–3.59
2	4.42	1.84–10.61	1.27	0.70–2.32	6.00	2.07–17.43	1.65	0.79–3.47
3	4.66	1.87–11.61	1.35	0.72–2.51	5.49	1.80–16.71	1.74	0.80–3.78
4	5.21	2.03–13.40	1.24	0.65–2.33	4.96	1.52–16.23	1.62	0.73–3.59

Model 1: unadjusted; model 2: model 1 adjusted for age and sex; model 3: model 2 further adjusted for education level, region, and season; model 4: model 3 further adjusted for physical activity and smoking and alcohol intake. To convert to SI units, multiply serum 25(OH)D by 2.496 (nanomoles per liter).

who did not participate in the fall follow-up were significantly older (mean age 81.7 ± 5.9 *vs.* 75.7 ± 6.6 yr in the participants). In addition, the response rate for participating in the fall follow-up was higher (96.5%) in subjects aged younger than 75 yr, as compared with the response rate in subjects aged 75 yr or older (92.8%). So participants of the present study may have been healthier, particularly in the oldest age group (healthy survivor effect). This selection may have resulted in an underestimation of the true association.

In a retrospective study in nursing home and hostel residents (mean age, 84 yr), serum 25(OH)D was not associated with a history of falling when confounders were taken into account (30). That study, however, was very small (83 subjects). In a larger prospective study in institutionalized subjects, serum 25(OH)D was associated with time to first fall, but again this association did not remain significant after adjustment for confounders (31). In another prospective study among residential care women (aged ~84 yr), Flicker *et al.* (32) did observe an independent association between serum 25(OH)D and the time to the first fall. The inconsistency in results of these two prospective studies may have been caused by a different duration of follow-up (10.2 months *vs.* up to 6 months) and the fact that both studies have examined only the time to the first fall. The first fall may be a coincidental fall with an extrinsic cause, in contrast to recurrent falls, which are often associated with intrinsic causes (3, 21). Extrinsic causes may have been different between the two studies, causing inconsistent results. The strength of the present study is that we were able to study vitamin D status in relation to recurrent falls, using a longitudinal study design. In addition, this is the first observational study on vitamin D status and falls that was performed in subjects who were mainly community dwelling (97.3% in our study sample).

We found an independent association of serum 25(OH)D with recurrent falls after 1 yr of follow-up. As described previously, 3-yr fall follow-up information is also available in the population that we studied (33). We found a similar significant association of baseline serum 25(OH)D and risk of falls during 3 yr of follow-up as compared with 1 yr of follow-up, although the strength of the associations was somewhat weaker (data not shown). We chose to show only the results of 1 yr of follow-up because the chance that vitamin D status has changed during follow-up increases after longer follow-up duration.

It was shown that a substantial proportion of recurrent falls in the elderly could be attributed to low serum 25(OH)D levels, as suggested by the population attributable fraction of 7.5% for two falls or more and 11.3% for three falls or more. In other words, 7.5 or 11.3% of the recurrent falls could possibly be prevented if serum 25(OH)D levels would be raised above 10 ng/ml in all the older persons. Therefore, it should be investigated in large intervention studies whether improvement of serum 25(OH)D levels (either by supplementation or sun exposure) could be used to prevent recurrent falling in the elderly. Because the population attributable fraction was even higher in persons aged between 65 and 75 yr as compared with the participants older than 75 yr, vitamin D supplementation could be particularly effective in the younger elderly. Previous supplementation studies usually included participants with a mean age of around 75 yr (18). Possible age group-specific effects of vitamin D supplementation within these older populations have not been evaluated yet and could be of interest for future studies.

In conclusion, the present study shows that low serum 25(OH)D levels (<10 ng/ml) are independently associated with a higher risk of recurrent falling in the elderly. For future research, it would be relevant to investigate the underlying mechanism that explains the association between serum 25(OH)D levels and risk of recurrent falling, and to explore the possibilities for prevention of recurrent falling by raising serum 25(OH)D levels in the general elderly population.

Acknowledgments

The authors thank Jan Poppelaars, Vianda Stel, Jan Smit, and Els Lommerse for their help with collecting and processing the data. The authors gratefully acknowledge the Endocrinology Laboratory of the Vrije Universiteit Medical Center for help with analyzing serum 25(OH)D.

Received March 6, 2006. Accepted May 1, 2006.

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This work was supported by ZonMW, The Hague. Data analysis has been made possible by Merck & Co., who partly sponsored M.B.S. to perform the analyses.

Disclosure Statement: This study is based on data collected in the context of the Longitudinal Aging Study Amsterdam (LASA), which is largely funded by the Ministry of Health, Welfare, and Sports of The Netherlands. N.M.v.S., S.M.F.P., R.M.v.D., M.V., and P.L. have nothing to declare.

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