Nutritional Status in Relation to Balance and Falls in the Elderly

A Preliminary Look at Serum Folate

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Key Words
Balance \cdot Dietary intake \cdot Elderly fallers \cdot Functional status \cdot Nutritional status

Abstract
Background/Aim: In elderly persons, fall-related injury is a serious public health problem. We investigated the impact of essential nutritional elements on falls in the elderly. Methods: Clinical function, balance, gait and disability tests and health and nutritional status assessments were performed. All subjects were interviewed regarding the occurrence of falls in the last year. Blood tests for serum vitamin D, folate and B\textsubscript{12} were conducted among a randomly selected subsample of 54 participants in the same month. Results: One hundred 65- to 91-year-old volunteers participated in the study, and 29 of them fell at least once during the past year. The depression score was higher (indicating more depressive symptoms) among fallers compared with non-fallers (4.0 \pm 3.2 vs. 2.5 \pm 2.3, respectively). The overall function score (indicating better function) was marginally higher in non-fallers. Subsequent comparisons between fallers and non-fallers were adjusted for overall function and depression scores. Serum folate was significantly lower in fallers (9.5 \pm 7.1 vs. 16.2 \pm 6.7 ng/ml, \textit{p} = 0.02). Dietary intake was equal in both groups. Correlation analyses indicate a significant association between vitamin D and the functional measurements: timed get up and go (negative), Berg balance test, overall functional score, lower extremity score and limitation score (positive correlation coefficients). Serum folate was highly and negatively associated with the number of falls and with prescribed medications and was the only protective factor against falls in a multivariate analysis. Conclusions: Vitamin D was related to most functional and balance measurements. Serum folate was protective against falls. For every 1 ng/ml increase in serum folate the occurrence of falls decreased by 19%.

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Introduction

More than one third of persons ≥65 years of age fall each year and 50% of persons >80 years of age experience at least one fall each year. The falls are recurrent in half of these cases [1, 2]. Approximately 1 in 10 falls results in a serious injury [3, 4]. Over one quarter of older people who sustain a hip fracture die within 12 months of the injury [5]. Identifying modifiable risk factors for falls may enhance the development of intervention programs to prevent falls.

Falls in the elderly are brought about by a number of factors acting in synergy [1, 5]. One category includes conditions affecting strength, namely medical frailty, sarcopenia or orthopedic abnormalities. The second category includes conditions affecting gait and balance, mainly neurologic diseases. Medications and polypharmacy (4 or more drugs) add to the above categories. Other categories include lifestyle factors, psychological, emotional condition and environmental factors [1–8].

Nutrition plays a cardinal role in over half of the above factors [3, 9], although studies relating nutritional factors to falls are scarce. Decreased energy and protein intake is related to lower lean body mass, sarcopenia and muscle weakness [10, 11]. Deficiencies in nutrients such as vitamins B₆, B₁₂, D and E, carotenoids, folic acid, iron and calcium have the potential to influence various physiological systems responsible for maintaining balance and postural stability and predispose to falls [3, 6, 7, 12–14]. Emotional factors, such as depression, are closely correlated with qualitative and quantitative malnutrition [15].

Chapuy et al. [16] and Dawson-Hughes et al. [17] have reported a significant reduction in nonvertebral fractures (32 and 58%, respectively) with long-term vitamin D and calcium supplementation (18 and 36 months). Bischoff-Ferrari et al. [18] showed that vitamin D supplementation appears to reduce the risk of falls among individuals with stable health by >20%. Vellas et al. [19] and Delmi et al. [20] showed poorer nutritional status among fallers compared with non-fallers.

Based on the above-described findings, we compared the dietary intake of specific fall-related nutrients between fallers and non-fallers. Another set of analyses was conducted relating a set of quantitative balance, gait, function and disability measures with serum levels of the above-selected nutrients. The purpose of our study is to elicit the specific role of dietary micronutrients in fall prevention. The study will also observe the putative mechanisms responsible for the effect of the selected micronutrients on gait, balance and falls.

Table 1. Characteristics of the study participants by falling status

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Fallers (n = 29)</th>
<th>Non-fallers (n = 71)</th>
<th>p value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>20 (69%)</td>
<td>53 (75%)</td>
<td>0.56</td>
</tr>
<tr>
<td>Married</td>
<td>13 (46%)</td>
<td>24 (36%)</td>
<td>0.33</td>
</tr>
<tr>
<td>Participation in physical activity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>high level</td>
<td>23 (79%)</td>
<td>58 (89%)</td>
<td>0.2</td>
</tr>
<tr>
<td>Education, years</td>
<td>12.4 ± 3.8</td>
<td>12.0 ± 4.0</td>
<td>0.7</td>
</tr>
<tr>
<td>Age, years</td>
<td>76.9 ± 7.2</td>
<td>79.0 ± 5.5</td>
<td>0.17</td>
</tr>
<tr>
<td>Prescribed medications, n</td>
<td>5.3 ± 3.2</td>
<td>4.9 ± 3.0</td>
<td>0.47</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>66.9 ± 9.7</td>
<td>66.6 ± 12.4</td>
<td>0.9</td>
</tr>
<tr>
<td>Sun exposure in the last week, min</td>
<td>35 ± 11.5</td>
<td>33 ± 10.2</td>
<td>0.8</td>
</tr>
<tr>
<td>Depression score</td>
<td>4.0 ± 3.2</td>
<td>2.5 ± 2.3</td>
<td>0.04</td>
</tr>
<tr>
<td>MMSE score</td>
<td>29.2 ± 0.9</td>
<td>28.9 ± 1.0</td>
<td>0.27</td>
</tr>
<tr>
<td>Health status score</td>
<td>1.0 ± 1.1</td>
<td>0.9 ± 0.7</td>
<td>0.6</td>
</tr>
<tr>
<td>Timed get up and go, s</td>
<td>9.4 ± 3.4</td>
<td>7.98 ± 2.3</td>
<td>0.09</td>
</tr>
<tr>
<td>Berg balance test</td>
<td>50.5 ± 4.6</td>
<td>52.5 ± 3.4</td>
<td>0.08</td>
</tr>
<tr>
<td>Limitation score</td>
<td>71.0 ± 12.5</td>
<td>74.3 ± 12.7</td>
<td>0.25</td>
</tr>
<tr>
<td>Overall functional score</td>
<td>60.1 ± 7.3</td>
<td>63.7 ± 11.4</td>
<td>0.06</td>
</tr>
<tr>
<td>Lower-extremity score</td>
<td>71.2 ± 10.8</td>
<td>75.3 ± 13.5</td>
<td>0.16</td>
</tr>
<tr>
<td>Single-task step execution time, s</td>
<td>1.0 ± 0.3</td>
<td>0.98 ± 0.3</td>
<td>0.35</td>
</tr>
<tr>
<td>Dual-task step execution time, s</td>
<td>1.2 ± 0.4</td>
<td>1.1 ± 0.4</td>
<td>0.27</td>
</tr>
</tbody>
</table>

* Figures are numbers or means ± SD.
* a χ² test (for sex, age and physical activity) and independent-sample t test.

Methods

Study Population

A total of 100 healthy volunteers (table 1), 65–91 years of age, were recruited from two senior living facilities in the Beer-Sheva region, Israel. Tenants were invited to attend lectures on the risk and outcomes of falls in old age. The rationale for the study was presented, too. The exclusion criteria were: (a) serious visual impairment, (b) inability to ambulate independently or with a cane, (c) score of ≥4 in the Mini Mental State Examination (MMSE) and (d) persons with impaired communication capabilities. Participants provided informed consent, in accordance with the ethical principles set out in the Declaration of Helsinki and approved by the Ethics Committee of the Soroka University Medical Center.

General Information

Demographic variables included sex, age, marital status, country of origin, years since immigrating to Israel if relevant and education. Supplementary data included living arrangements and minutes of sun exposure in the last week.

Definition of Fallers

A fall was defined as ‘unexpected and involuntary loss of balance, causing the person an undesired contact with the ground’ [1]. The occurrence of falls was assessed retrospectively by asking...
the participants ‘Did you fall during the last year?’ If the patient reported he/she had experienced a fall they were asked about the number of falls that they experienced in the last year.

**Dietary Assessment**

Dietary assessment was performed using a validated food frequency questionnaire (FFQ), specifically developed for the elderly population [21].

**Anthropometric Measurements**

Nutritional status was determined using anthropometric measurements including weight and height. Body weight was measured using a single calibrated scale (Detecto, Webb City, Mo., USA) with the patient wearing light clothing and no shoes. Height was measured with a wall-mounted stadiometer.

**Blood Measurements**

Blood tests including serum 25(OH)D, 1,25 (OH)₂D, serum B₁₂ and folate were obtained from a random subsample of the participants (n = 54) in May 2006. Due to budgetary limitations, blood tests were drawn in a subsample. These participants were chosen from the lists of both protected living by random number. Frequencies questionnaire (FFQ), specifically developed for the elderly population. Results are expressed in nanograms 25(OH)D per milliliter serum. Serum levels of the active metabolite of vitamin D, 1,25-dihydroxyvitamin D [23]. Results were expressed in picograms 25(OH)D per milliliter serum. Each serum sample was tested in duplicate (coefficients of variation: 5–7% for both tests).

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Serum folate and vitamin B₁₂ levels were measured using an immunoassay (Abbott AxSYM System) [22] at the Soroka Medical Center. Besides the controls which accompanied each assay, the quality control (QC) systems used were: (1) daily QC system of Dade (Newark, Del., USA), and (2) random sample QC of NEQAS (Sheffield, UK), twice a month. Most of the tests were carried out on the Hitachi 747 autoanalyzer. This apparatus was calibrated with Boehringer’s calibrator for automated systems on a daily basis (the coefficient of variation was <10% for both tests).

In the present study, serum 25(OH)D levels were determined using the IDS OCTEIA 25(OH)D kit (IDS AC-57F1; Immunodiagnostic Systems, Boldon, UK) [23]. Results are expressed in nanograms 25(OH)D per milliliter serum. Serum levels of the active metabolite of vitamin D, 1,25-dihydroxyvitamin D [24]. Results were expressed in picograms 25(OH)D per milliliter serum. Each serum sample was tested in duplicate (coefficients of variation: 5–7% for both tests).

To determine vitamin deficiency, we used the following cut-offs, which correspond to the normal ranges of the assays described in the literature [25]. Folate was considered deficient when the serum folate level was <11 nmol/l (<5 ng/ml); vitamin B₁₂ deficiency was defined as <147 pmol/l. The level of deficiency for 25-(OH)-D was defined as 25-(OH)-D <10 ng/ml [26].

**Physical Activity**

Physical activity was assessed using a modification of the National Health and Nutrition Examination Survey [27]. Participants reported about their participation in specific physical activities and the frequency and intensity of their activity. For intensity, a scale from 1 to 3, where 3 represents high intensity, was used.

The scale for frequency was also from 1–3, where 3 represents >4 times/week and 1 represents <1/week or never. We multiplied both scores (frequency and intensity) into one activity score with a scale from 1 to 9. We then determined the median value of the combined score. Values below the median were considered low activity and values over the median as high activity.

The modification of the questionnaire was validated against calculated total energy expenditure with a relative validity of r = 0.89 (p < 0.01). The reliability of the questionnaire was r = 0.97 (p < 0.01) [28].

**Health Status**

The participants brought all their prescribed medications, hormone replacement therapy for women and supplements to the clinic visit. The interviewer recorded all prescription and non-prescription drugs, indicating dosage and frequency of use. The number of prescribed medications was charted based on the above information. As only 4% of the participants were receiving hormone replacement therapy, they were not included in the analyses.

Evaluation of the health status in relation to falls was done by a geriatric physician who reviewed all the participants’ medical files. The score was specifically developed for the current study and was based on a previously developed score to assess the risk of falls in the elderly. The score was validated and successfully used in our area [29]. The diseases diagnosed were divided into three categories according to their known association with function, disability and falls. The categories included: (1) any neurological disease, e.g. Parkinson’s disease (categorized as 1 [30–32]); (2) diseases with possible or indirect effect on falls or diseases with debilitating condition, e.g. diabetes or cardiovascular disease (categorized as 0.5 [33, 34]) and (3) all other diseases (categorized as 0). Parallel division was done for the medications used by the participants. The sum of both was used as a health score [29].

**Gait and Balance Assessment**

All the gait and balance tests were described in detail elsewhere [35]. In summary, the test included the following two sub-tests:

(1) In the voluntary step execution test [35–37], subjects were instructed to stand relaxed on a force platform and to take a step as quickly as possible following a somatosensory cue. The measurements include single- and dual-task step execution times.

(2) The Berg balance test was used as another measurement of balance [38, 39] – a well-established clinical measure of balance function. The scoring is on 14 tasks graded on a scale from 0 to 4 to evaluate balance function under different conditions.

**Function and Disability Assessment**

The Late-Life Function and Disability Index (LL-FDI) was assessed [40] to determine physical function and disability. The LL-FDI is a scale specifically designed to be sensitive to changes in physical function and disability. Overall functioning and upper and lower extremity subscales are each scored on a scale from 0 to 100, with higher scores indicating higher levels of functioning.

**Cognitive Status**

Cognitive status was assessed using the Folstein MMSE [41], with higher scores indicating better cognitive function.
Depressive symptoms were assessed using the short form of the Geriatric Depression Screening Scale [42], with higher scores indicating more depressive symptoms.

Statistical Analyses
Statistical analyses were conducted using SPSS (version 14). All variables were first assessed for their normal distribution. We transformed values for dietary variables to normalize their distribution using natural logarithmic transformation and compare between fallers and non-fallers. Non-normally distributed variables such as the number of falls were tested using non-parametric tests. Other variables were normally distributed among our population and thus were tested accordingly.

In the first table, unadjusted statistical analyses were performed using independent-sample t tests to compare fallers and non-fallers. Other variables were normally distributed among our population and thus were tested accordingly.

General linear models were used to compare blood tests (table 2) and log-transformed dietary intake variables (table 3) between fallers and non-fallers. Based on the findings from table 1, overall functional as well as depression scores were used as covariates in the models.

A separate analysis was conducted relating serum levels of micronutrients to each individual parameter impacting falls. Pearson or Spearman’s (for non-parametric variables) correlation coefficients were used to determine the associations between serum vitamins and functional, balance and gait measurements (table 4).

Logistic regression models were used to determine the independent contribution to the risk of falls of the variables found to be significant in the univariate analyses. Goodness-of-fit measures were used to select the best-fitting model.

Results

Subject Characteristics
One hundred volunteers (65–91 years old) participated in the study. Of the 29 who fell at least once during the past year, 11 were multiple fallers (2 or more falls); there were 71 non-fallers. Demographic anthropometric and health characteristics of the participants by their falling status are described in table 1. No difference was shown between fallers and non-fallers regarding sex, marital status, physical activity, education, age, number of prescribed medications, weight and cognitive function. A significant difference in the depression score was shown between fallers and non-fallers (4.0 ± 3.2 vs. 2.5 ± 2.3, p = 0.04), with a higher score indicating more depressive symptoms. Regarding the overall functional score, a trend to significance (p = 0.06) was found between fallers and non-fallers (60.1 ± 7.3 vs. 63.7 ± 11.4).

The serum vitamin levels by falls are shown in table 2 for a random subsample of the participants adjusted for the overall function and depression scores. A non-significant trend to decreased serum levels of vitamins D, expressed as 25(OH)D, and B12 in relation to falls was shown. These relationships were found to be significant for folate, suggesting that as serum folate decreases, the risk for falls increases.

Table 2. Mean serum levels of vitamins among a subsample of the participants [54] by falling status adjusted for the overall functional and depression scores

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Non-fallers (n = 43)</th>
<th>Fallers (n = 11)</th>
<th>p value</th>
<th>Fallers (&gt;1 fall; n = 7)</th>
<th>p value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>25(OH)D, ng/ml</td>
<td>35.7 ± 9.1</td>
<td>31.1 ± 9.7</td>
<td>0.16</td>
<td>29.0 ± 11.0</td>
<td>0.09</td>
</tr>
<tr>
<td>1,25(OH)D, pg/ml</td>
<td>31.6 ± 16.9</td>
<td>26.1 ± 16.0</td>
<td>0.46</td>
<td>14.5 ± 9.7</td>
<td>0.26</td>
</tr>
<tr>
<td>B12, pmol/l</td>
<td>454.6 ± 226.6</td>
<td>378.1 ± 147.2</td>
<td>0.32</td>
<td>347.9 ± 176.8</td>
<td>0.38</td>
</tr>
<tr>
<td>Folate, ng/ml</td>
<td>16.2 ± 6.7</td>
<td>10.3 ± 5.9</td>
<td>0.014</td>
<td>9.5 ± 7.1</td>
<td>0.02</td>
</tr>
</tbody>
</table>

* Fallers (≥1 fall in the last year) vs. non-fallers.

Table 3. Dietary intake of the participants by their falling status adjusted for overall functional and depression scores

<table>
<thead>
<tr>
<th>Nutrients (per day)</th>
<th>Fallers (n = 29)</th>
<th>Non-fallers (n = 71)</th>
<th>p value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protein, g</td>
<td>68.9 ± 16.6</td>
<td>76.5 ± 23.3</td>
<td>0.11</td>
</tr>
<tr>
<td>Energy, kcal</td>
<td>1,794.8 ± 412.6</td>
<td>1,898.4 ± 472.5</td>
<td>0.3</td>
</tr>
<tr>
<td>Calcium, mg</td>
<td>667.0 ± 214.0</td>
<td>723.5 ± 313.7</td>
<td>0.38</td>
</tr>
<tr>
<td>Iron, mg</td>
<td>12.7 ± 3.1</td>
<td>13.3 ± 3.4</td>
<td>0.45</td>
</tr>
<tr>
<td>Magnesium, mg</td>
<td>307.4 ± 62.1</td>
<td>326.8 ± 86.1</td>
<td>0.27</td>
</tr>
<tr>
<td>Vitamin D, IU</td>
<td>83.7 ± 51.9</td>
<td>88.2 ± 60.1</td>
<td>0.69</td>
</tr>
<tr>
<td>Vitamin E, mg</td>
<td>12.3 ± 3.6</td>
<td>12.2 ± 3.8</td>
<td>0.93</td>
</tr>
<tr>
<td>Vitamin B6, mg</td>
<td>2.3 ± 0.5</td>
<td>2.3 ± 0.7</td>
<td>0.87</td>
</tr>
<tr>
<td>Vitamin B12, µg</td>
<td>5.9 ± 5.9</td>
<td>6.3 ± 5.7</td>
<td>0.76</td>
</tr>
<tr>
<td>Folate, µg</td>
<td>416.3 ± 141.9</td>
<td>418.1 ± 116.3</td>
<td>0.95</td>
</tr>
</tbody>
</table>
The levels of deficiencies in our group were low; the prevalence of serum vitamin D, 25(OH)D ≤10 ng/ml was 10% among fallers, 0% among non-fallers and 2% among the whole group. None of our participants had serum vitamin B12 ≤147 pmol/l and the prevalence of serum folate ≤5 ng/ml was 20% among fallers, 5% among non-fallers and 4% among the whole group.

A comparison of dietary intake of selected nutrients between the groups is shown in Table 3. None of the comparisons revealed significant results, although a trend to a lower dietary intake of most nutrients was shown among fallers.

Correlation coefficients between selected functional and balance measurements and blood tests for vitamins among a subsample of 54 participants are presented in Table 4. Both metabolites of vitamin D [25(OH)D and 1,25(OH)D] were significantly correlated with most of the functional and balance measurements including timed get up and go (negative), Berg balance test (positive) and LL-FDI indices (positive). Single-task step execution time was correlated with 25(OH)D only. Serum folate was significantly and negatively correlated with the number of falls (using Spearman’s correlation coefficient) in the last year and with prescribed medications.

Variables that had any association with falls in univariate analyses were entered into a logistic regression model. Those included in the final model were overall functional score, dual-task step execution time, geriatric depression score, number of prescribed medications and serum folate. Serum folate was the only protective factor against falls. For every 1 ng/ml rise in serum folate, the risk for falls decreased by 19% after adjusting for the number of medications, depression and functional scores and dual-task step execution time.

### Discussion

Balance, gait, function and disability measures are reliant on numerous physiological mechanisms. To ascertain normal function, gait and balance, adequate performance of several tissues is required. These include bone, muscle connective tissue and nervous system. Various nutritional elements may thus have a contribution to each of these parameters. Surprisingly, the only vitamin studied in depth in relation to falls is vitamin D [18, 43, 44], which was indeed shown to be related to gait, balance and posture in different settings [43, 44]. We showed an interesting association between blood levels of folate and the occurrence of falls in both univariate and multivariate analyses. Serum vitamin D levels were associated with multiple balance and functional outcomes that may lead to falls.

The comparison of dietary intake between fallers and non-fallers showed decreased nutrient intake across the board among fallers; however, the difference did not reach statistical significance. The overall dietary intake was higher than that found in prior studies conducted in our area [45, 46]. Additionally, our population had a higher education level and a higher than average socio-economic level. The mean energy intake in the Negev...
Nutrition Study [45] was $1.487 \pm 604$ versus $>1,800$ kcal/day in our current group. Thus, this study population represents a segment of the elderly population which is more educated, better nourished and more functional.

The effect of vitamin D on fall prevention has already been established, although the mechanism is debatable. One explanation is that 1,25-hydroxyvitamin D, the active metabolite of vitamin D, binds to a highly specific nuclear receptor in muscle tissue [47, 48], leading to improved muscle function, increased muscle tonus and reduced risk of falling. Vitamin D plus calcium improved body sway by 9% in elderly ambulatory women [44] and by 4–11% in institutionalized elderly women compared with calcium alone [47]. The effects of vitamin D on muscle may be mediated by de novo protein synthesis [48], affecting muscle cell growth through the highly specific nuclear vitamin D receptor expressed in human muscle [43, 47]. In a meta-analysis by Bischoff-Ferrari et al. [18], vitamin D supplementation resulted in a reduction in the risk of falls by >20%. Our data showed a trend to lower serum vitamin D levels among fallers, particularly among multiple fallers, and an interesting negative relationship between serum vitamin D and functional and balance measurements.

It is interesting to note that 93% of our participants fell within the normal levels of serum 25(OH)D (20–60 ng/ml). In our group, only 2% presented with 25(OH)D deficiency (i.e. 25(OH)D <10 ng/ml). The rarity of vitamin D deficiency came as a surprise for us as studies from middle-eastern countries including Israel show low levels of serum vitamin D among community-dwelling elderly as well as other elderly populations [49–52]. Very low serum 25(OH)D levels have been reported in the Middle East, e.g. Turkey, Lebanon, Jordan and Iran [49, 50, 53–55]. In these countries, serum 25(OH)D was lower in women than in men and associated with clothing habits. In studies conducted in Israel, where the sun shines most of the year, vitamin D deficiency was >35% [51, 56, 57]. These findings suggest that the norm for serum vitamin D should be set at a higher level than the customary cut-off of 10 ng/ml.

We found serum folate to be significantly associated with falls, with a trend toward a linear relationship when we added a comparison with people who fall more than once. It is interesting to note that in both fallers and non-fallers the mean level was much beyond the recommended cutoff level of 5 ng/ml [27]. In all categories, including fallers, folate levels were beyond the accepted norms. The relationship between folate and the occurrence of falls was not reported in the literature, but it was significant in both univariate and multivariate analyses, where serum folate was the only protective factor against falls. For each 1 ng/ml increase in serum folate, the risk for falls was decreased by 19%. In recent years, there have been several publications regarding the association between folate and B12 levels and fractures. In a Japanese study [52] published in 2005, combined treatment with folate and B12 in elderly patients after stroke was effective in reducing the risk of a hip fracture, although the decrease was not related to a decrease in falls as the number of falls in both the case and the control groups were similar. In our study, the association of falls and balance measurements with serum B12 was less pronounced.

The mechanism underlying the negative association between folate and falls found among our participants is still obscure. Nonetheless, it may be related to folate contributing to adequate cell division, or to the toxic effect of elevated homocysteine levels stemming from lower folate levels. The association between folate and falls found in this study is consistent and significant, even in the face of a small sample, and thus deserves further attention. We strongly feel that folate needs to be further studied in relation to falls.

Our study suffers from several limitations. The first is its retrospective design. Falls were assessed using a questionnaire that referred to the prior year; therefore, the estimate of falls may be underreported, especially falls that were not associated with severe outcomes. However, our findings agree with the estimated incidence rates of falls reported in other countries [1, 2, 5]. Tinetti et al. [1] has shown that regarding self-reports of falls good-excellent reliability was attained in community-dwelling elders. Cummings et al. [58] reported that failure to recall falls was related to MMSE scores <27. The range of MMSE scores was 26–30 in our study; only 9 subjects (9%) scored between 26 and 27 points. The recall of falls, therefore, was presumed to be good, based on the high cognitive function of our sample. The second limitation is our use of the FFQ to assess long-term dietary intake. This questionnaire tends to overestimate dietary intake [59] and in some cases the portion size used in the questionnaire is appropriate for younger age groups. In order to overcome this limitation, we assigned portion sizes and nutritional values for each line in the questionnaire based on values that were collected in an elderly survey [23]. This method was described by Subar et al. [60]. We therefore assume that our dietary data were reliable. However, in future studies we recommend the inclusion of larger samples in order to decrease the standard deviation of nutrient intake variables. It is worth noting that our study was con-
ducted in a highly selected group of high-socioeconomic participants. Therefore, in our opinion, the results may either correctly estimate or underestimate the extent and contribution of micronutrient deficiency to falls. We feel it is unlikely that wide population studies will show a nutritional status superior to that shown in our participants.

In conclusion, our data indicate interesting associations between serum measurements of vitamin D, folate and to a lesser extent vitamin B_{12}. These associations are preliminary and need to be evaluated prospectively and in larger samples. For nutritional deficiencies in the elderly, the cutoffs for these vitamins need to be further evaluated as our data suggest that, even within the normal range, participants with lower values are at an increased risk for falls or deterioration of their functional and balance abilities.

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