Dietary strategies for improving folate status in institutionalized elderly persons

Laura M. Bermejo¹*, Aránzazu Aparicio¹, Elena Rodríguez-Rodríguez¹, Ana M. López-Sobaler¹, Pedro Andrés² and Rosa M. Ortega¹

¹Departamento de Nutrición, Facultad de Farmacia, Universidad Complutense, 28040 Madrid, Spain
²Laboratorio de Técnicas Instrumentales, Sección Departamental de Química Analítica, Facultad de Farmacia, Universidad Complutense, 28040 Madrid, Spain

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The aim of this work was to compare the efficacy of two strategies designed to improve folate status: increasing the intake of vegetables, and the consumption of a folic acid-fortified food. Residents (126) from three old people’s homes in the Madrid region (Spain) were studied. To each centre a dietary intervention was assigned to be followed for 6 months: (1) the consumption of margarine fortified with 200 μg folic acid/10 g portion (centre M), (2) increasing the consumption of vegetables to three servings per day (centre V), (3) control (centre C). At the beginning and end of the intervention period the subjects’ intakes, serum and erythrocyte concentrations of folate were measured. The use of fortified margarine (centre M) led to a significant increase in folate intake (260·9 μg/d), serum concentration (10·3 (SD 8·3) nmol/l) and erythrocyte concentration (638·4 nmol/l). At centre V the increase in total vegetable intake achieved was very poor; these foods met with very poor acceptance, although the intake of certain vegetables particularly rich in folate improved. Therefore, the intake of this vitamin increased a little (26·7 (SD 33·0) μg/d); erythrocyte folate concentration also increased somewhat (460·5 nmol/l), although less than centre M. The daily consumption of margarine fortified with folic acid was the more effective strategy for improving the folate status of the study subjects.

Folate: Dietary strategies: Vegetables: Fortified food: Elderly persons

Folate deficiency is one of the most common vitamin deficiencies in elderly people¹,². The most common problems associated with this deficiency are anaemia³, cancer, CVD, depression and dementia⁴–⁶. Given the importance of this vitamin, the latest intake reference figures from the USA⁷ and the recommended intake for the Spanish population⁸ have been raised to 400 μg/d for men and women over 51 years of age.

The aim of the present work was to improve the folate status of elderly people either via the consumption of a fortified food or increasing the consumption of vegetables to three servings per day.

Subjects and methods

The study subjects were 126 elderly people (all aged over 65 years) who resided at three old people’s homes in the Madrid region (Spain). All subjects were informed of the nature of the study and gave their written consent to be included. The study was approved by the Research Committee of the Faculty of Pharmacy.

Study design

Prior to the dietary interventions, a baseline study of the nutritional status of the subjects was made via dietetic, anthropometric, haematological and biochemical examinations. All initial data were collected between April and May 2001 and the intervention was designed to run from June to November 2001.

The strategies to improve the folate status were planned to involve either the consumption of a fortified food or increasing the consumption of vegetables. To decide upon which fortified food to use, information was sought on the food habits of elderly people⁹,¹⁰. Since fortified breakfast cereals are not normally consumed by Spanish elderly, a low-fat margarine was chosen to substitute that normally used at the centres at breakfast time. This avoided an intervention-induced increase in fat intake.

The 6-month interventions undertaken at the three centres were: (1) Centre M: supplementation of the diet with 10 g margarine fortified with 200 μg folic acid/d. Together with the supply from other dietary sources (a further 200 μg/d), this would have approximated the folic acid intake to the
Methods

Baseline and final dietetic studies. All foods and drinks consumed by the subjects were recorded over a period of 7 d using the ‘precise individual weighing’ method\(^{(17)}\). Data were collected at all three centres under the same conditions: the same, trained team collected the data at each centre and did so in the same fashion, data collection began on the same day of the week, and the same measuring instruments were used.

The subjects also kept a ‘food record’ to provide information on foods and drinks taken between established meal times, e.g. food provided by their relatives or that which they bought at the centres’ cafeterias or elsewhere.

The energy and nutrient contents of all foods and drinks consumed were calculated using the Food Composition Tables of the Instituto de Nutrición\(^{(12)}\), complemented with those of Moreiras et al.\(^{(13)}\). These intakes were then compared with those recommended for the Spanish population\(^{(8)}\).

Energy expenditure was calculated using equations proposed by the WHO\(^{(14)}\), multiplying the basal energy expenditure by the corresponding activity coefficient. To determine these coefficients, all subjects completed a questionnaire that reflected the number of hours devoted to different activities during the day\(^{(15)}\).

Baseline and final anthropometric studies. The subjects’ weight was measured using a Seca Alpha digital electronic scale (range 0·1–150 kg) (Seca Alpha, Igny, France; range: 0·1–150 kg). Knee–heel lengths were also measured. This measurement allows an estimate to be made of subject weight using the formula of Chumlea measurement allows an estimate to be made of subject weight using the formula of Chumlea\(^{(16)}\),

\[
\text{height} = \text{weight} \times \frac{1}{\text{height}} \times 0.1 - 150 \text{ kg}
\]

This formula permits the calculation of BMI.

All measurements were taken with subjects in bare feet and wearing only their underwear. Measurements were taken following WHO recommendations\(^{(17)}\).

Baseline and final biochemical studies. Blood samples were taken first thing in the morning after a 12 h overnight fast and maintained at 4–6°C until analysis, which was always performed within 48 h.

Serum and erythrocyte folate were determined by RIA using the Vitamin B\(_{12}/\)Folate Dual Radioassay Kit (Diagnostic Product Corp., Los Angeles, CA, USA), and employing a model 1612 Gamma Counter (Nuclear Enterprises Ltd, Edinburgh, UK)\(^{(18)}\) (CV = 4·5 and 4·9 %, respectively).

Hb level was determined using a Coulter S Plus apparatus\(^{(19)}\).

Homocysteine levels were determined by HPLC (CV = 6·5 %). Separation was achieved with an RP-18 column (Symta, Madrid, Spain) using an intelligent pump (Merck-Hitachi L-6200 A; Hitachi, Tokyo, Japan). Detection was performed by fluorescence spectrophotometry\(^{(20)}\).

Baseline and final health study. Information was collected on the diseases/disorders suffered by the subjects and the medications they took.

Statistical analysis

Means and standard deviations of all variables were calculated. To detect differences between the participating centres, one-way ANOVA was used followed by the Newman–Keuls test. The Student t test for paired samples was used to analyse the differences between the mean baseline and final results within centres. Differences between population percentages with associated different variables were analysed after first transforming binomially distributed results to a normal distribution using continuity correction\(^{(21)}\). Significance was set at \(P < 0.05\). Calculations were performed using the RSIGMA BABEL 2000 software package (Horus Hardware, Madrid, Spain).

Results

The percentage of men and women was similar (64 % men, 36 % women) between centres. The mean age of the subjects was 82·4 (SD 7·3) years.

V subjects had a baseline weight and BMI significantly greater than those of M and C. This difference was taken into account in the statistical treatment of the results in order to adjust for its possible effect.

Baseline and final serum vitamin B\(_{12}\) levels were measured on participants and there were no subjects with serum B\(_{12}\) below the conventional cut-off point (148 pmol/l)\(^{(22)}\) and the levels did not change during the intervention period in any of the intervention groups.

Table 1 shows the subjects’ baseline and final folic acid intakes and serum and erythrocyte folate concentrations. The percentage of subjects with intakes of < 67 % of folate recommended dietary intakes\(^{(8)}\) was very high at all three centres (C, 97·8 %; M, 97·4 %; V, 100 %, NS).

Further, only in centre M the percentage of subjects with intakes of folate below 400 μg/d\(^{(8)}\) diminished from 100 % at the start of the study to 43·2 % at the end (\(P < 0·001\)). The change in the percentage of subjects whose folate intake was less than two-thirds of that recommended was even more remarkable: 97·4 % at baseline and 0·0 % at the end of the intervention (\(P < 0·001\)).

On a day per month of the intervention, the quantity of vegetables offered on the menu at centre V was inspected. The final mean weight of vegetables offered was 526 g/d (3·01 servings/d). However, V subjects did not eat all the vegetables provided (Table 1); the real consumption rate was 291 g/d (1·66 (SD 0·36) servings/d). Although the overall intake of...
vegetables did not increase after 6 months, the folate intake increased significantly (Table 1), as a consequence of a specific increase in the consumption of vegetables, particularly rich in folate (Swiss chard 3.3 (SD 5.6) v. 14.4 (SD 7.7) g/d, \( P < 0.001 \); spinach 1.6 (SD 1.1) v. 6.7 (SD 3.2) g/d, \( P < 0.001 \); peas 6.6 (SD 3.0) v. 15.0 (SD 5.5) g/d, \( P < 0.001 \); broad beans 0.0 v. 1.9 (SD 1.2) g/d, \( P < 0.001 \).

At the end of the intervention, only in the centre M, the serum folate concentration was significantly higher than at baseline (Table 1). In addition, the percentage of M subjects with serum folate levels below the reference value (≤13.6 nmol/l) fell between baseline and the end of the intervention, from 36.8 to 61% (\( P < 0.001 \)).

The erythrocyte folate concentration of the subjects of all three centres increased significantly after the intervention compared to baseline (Table 1). However, the increase experienced by M subjects was significantly greater than that experienced by V and C subjects.

Hb values were measured on participants and did not change during the intervention period in any of the intervention groups (Table 1).

Homocysteine concentration decreased in M and V subjects (Table 1), although these variations were not significant.

In addition, a negative correlation was found with the folate intake variation and the homocysteine levels variation (\( r = -0.4591, P < 0.001 \)) in M subjects.

Discussion

The strategy based on the use of the fortified margarine led to the greatest increase in folate intake, and best improved the coverage of the recommended intake. It also led to significant increases in serum and erythrocyte folate levels. This strategy therefore achieved a significant improvement in the folate status of M subjects. With this strategy, the intake of folate achieved at 6 months (422 μg/d) was similar to that reported by other authors who incorporated different fortified foods into the diets (460 μg folate/d\(^{22}\)) and 518 μg folate/d\(^{23}\)) of other population subgroups.

Serum folate concentration is an indicator of the recent intake of this vitamin, while erythrocyte folate levels reflect intake over the previous months\(^{24}\). Since the study was performed between June and November, it might be argued that the final erythrocyte folate levels reflect a normal summer increase in vegetable consumption. However, this would have affected all three centres equally, and the final

Table 1. Changes in vegetable intake, folate intake, blood folate variables and Hb and homocysteine levels due to the interventions\(\text{[1]}\)

<table>
<thead>
<tr>
<th>(Mean values and standard deviations)</th>
<th>Baseline</th>
<th>Final</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vegetable consumption (g/d) (n 126)</strong></td>
<td>264 86·8</td>
<td>292 79·0</td>
<td>4·4 78·5</td>
</tr>
<tr>
<td>Centre C</td>
<td>264 86·8</td>
<td>262 58·6</td>
<td>2·2 66·8</td>
</tr>
<tr>
<td>Centre M</td>
<td>293 88·6</td>
<td>292 79·0</td>
<td>0·5 88·2</td>
</tr>
<tr>
<td>Centre V</td>
<td>295 71·8</td>
<td>291 63·7</td>
<td>1·3 78·5</td>
</tr>
<tr>
<td>ANOVA</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Folate intake (μg/d) (n 126)</strong></td>
<td>16·4 1·2</td>
<td>17·4 1·1</td>
<td>1·0 1·1</td>
</tr>
<tr>
<td>Centre C</td>
<td>16·4 1·2</td>
<td>17·4 1·1</td>
<td>1·0 1·1</td>
</tr>
<tr>
<td>Centre M</td>
<td>16·0 1·1</td>
<td>17·5 1·1</td>
<td>1·5 1·2</td>
</tr>
<tr>
<td>Centre V</td>
<td>19·0 1·1</td>
<td>21·9 1·1</td>
<td>2·9 1·1</td>
</tr>
<tr>
<td>ANOVA</td>
<td>P &lt; 0·01</td>
<td>P &lt; 0·01</td>
<td>P &lt; 0·01</td>
</tr>
<tr>
<td><strong>Serum folate (nmol/l) (n 107)</strong></td>
<td>14·4 7·7</td>
<td>13·7 7·7</td>
<td>1·7 7·7</td>
</tr>
<tr>
<td>Centre C</td>
<td>14·4 7·7</td>
<td>14·5 7·7</td>
<td>0·1 7·7</td>
</tr>
<tr>
<td>Centre M</td>
<td>16·1 7·7</td>
<td>16·6 7·7</td>
<td>0·5 7·7</td>
</tr>
<tr>
<td>Centre V</td>
<td>17·7 7·7</td>
<td>17·0 7·7</td>
<td>0·7 7·7</td>
</tr>
<tr>
<td>ANOVA</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Erythrocyte folate (nmol/l) (n 96)</strong></td>
<td>588 900</td>
<td>902 900</td>
<td>314 900</td>
</tr>
<tr>
<td>Centre C</td>
<td>588 900</td>
<td>902 900</td>
<td>314 900</td>
</tr>
<tr>
<td>Centre M</td>
<td>748 900</td>
<td>1403 900</td>
<td>655 900</td>
</tr>
<tr>
<td>Centre V</td>
<td>698 900</td>
<td>1030 900</td>
<td>332 900</td>
</tr>
<tr>
<td>ANOVA</td>
<td>P &lt; 0·01</td>
<td>P &lt; 0·01</td>
<td>P &lt; 0·01</td>
</tr>
<tr>
<td><strong>Hb (g/l) (n 117)</strong></td>
<td>126 58·6</td>
<td>126 58·6</td>
<td>0·0 0·0</td>
</tr>
<tr>
<td>Centre C</td>
<td>126 58·6</td>
<td>126 58·6</td>
<td>0·0 0·0</td>
</tr>
<tr>
<td>Centre M</td>
<td>126 58·6</td>
<td>126 58·6</td>
<td>0·0 0·0</td>
</tr>
<tr>
<td>Centre V</td>
<td>126 58·6</td>
<td>126 58·6</td>
<td>0·0 0·0</td>
</tr>
<tr>
<td>ANOVA</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td><strong>Homocysteine (μmol/l) (n 104)</strong></td>
<td>18·0 5·2</td>
<td>16·5 5·8</td>
<td>1·5 5·8</td>
</tr>
<tr>
<td>Centre C</td>
<td>18·0 5·2</td>
<td>18·0 5·2</td>
<td>0·0 0·0</td>
</tr>
<tr>
<td>Centre M</td>
<td>16·1 5·4</td>
<td>16·1 5·4</td>
<td>0·0 0·0</td>
</tr>
<tr>
<td>Centre V</td>
<td>17·7 5·6</td>
<td>16·5 5·8</td>
<td>1·2 5·8</td>
</tr>
<tr>
<td>ANOVA</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>
concentrations recorded for the centre M subjects were higher than those of the subjects at the other centres. This shows the increase to have been caused by the intake of the fortified margarine. Most of studies performed in different groups\(^{(23,24,26,27)}\) report folate intake to increase when supplements, fortified foods or natural foods rich in folate are provided. However, increases in erythrocyte folate concentration are reported to be much greater when fortified foods are taken, because synthetic folic acid monoglutamate is more bioavailable than the natural polyglutamate in foods\(^{(28)}\). In addition, folic acid monoglutamate is more stable than its polyglutamate counterpart during storage, preparation and cooking\(^{(29)}\).

The strategy based on increasing the number of servings of vegetables consumed did not have the impact desired. The final dietetic study showed that the consumption of vegetables by V subjects was smaller than that which their menus would have allowed; the subjects largely rejected these foods. Nonetheless, these menus were designed to provide vegetables, particularly rich in folate (Swiss chard, spinach, peas, broad beans and green beans), and while the overall intake of vegetables did not increase, the intake of these particular vegetables did. This may explain why V subjects showed an increase in folate intake (Table 1). However, despite this increase in folate intake, the percentage of V subjects with intakes <67% that recommended only decreased from 100 to 92.7%. Thus, this strategy was not able to allow the recommended intake of this vitamin to be achieved, nor did it increase the serum folate concentration (Table 1), although their increased erythrocyte folate concentration could reflect their increased intake of certain types of folate-rich vegetables over the study period.

Previous studies have been carried out for less than 4 months\(^{(23,24,27,30,31)}\) and they have combined different foods: vegetables, fruits, pulses, nuts and breakfast cereals. Nevertheless, in the present study, the dietary modification strategy was focused on increasing only the consumption of vegetables since they are folate-rich. Along with cereals these were the foods whose consumption was most widely different to that recommended\(^{(2,23)}\).

Some studies have shown that the elderly suffer certain physical barriers with respect to fruit and vegetable consumption and have deeply rooted food habits\(^{(32)}\), making it difficult to change their long-term dietary patterns, as the present results show. Some studies indicate that 4–5 months may be needed for changes to be seen in erythrocyte folate levels following supplementation with the vitamin or an increase in the consumption of vegetables\(^{(33)}\). For this reason a 6-month study period was chosen. Further, longer intervention times may improve the chances of having an impact on food habits; in the present study it was hoped that this would promote the consumption of vegetables among V subjects, although success was limited.

Other authors, according to the present results, have observed an improvement in homocysteine levels when the folate intake increases that could have important benefits on elderly health\(^{(23,24,27)}\).

The results suggest that improving the folate status of elderly people may be easier to achieve via the use of fortified foods, although further studies will be necessary to confirm this. However, the need to promote the consumption of vegetables by this population should not be overlooked.

The consumption of vegetables is low among the elderly yet there is good evidence that vegetable intake is associated with important health benefits\(^{(34)}\).

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References


