Adequacy of essential fatty acid, vitamin D and vitamin E intake: Implications for the ‘core’ and ‘extras’ food group concept of the Australian Guide to Healthy Eating

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Abstract
Objective: To assess the implications of new recommendations for essential fatty acids, vitamin D and vitamin E on the classification of margarines and vegetable oils as ‘extras’ in the current Australian Guide to Healthy Eating.
Design: The role of margarines and vegetable oils as sources of essential fatty acids, vitamin D and vitamin E was examined in two ways. First, data from the 1995 National Nutrition Survey were assessed and, second, sample diets conforming to the Australian Guide to Healthy Eating were modelled and analysed.
Subjects: For the assessment of national intake, subjects were a representative sample of 13 858 Australians, surveyed in the 1995 National Nutrition Survey.
Main outcome measures: Relative contributions of margarines and oils, the ‘core’ food groups and ‘extras’ categories of the Australian Guide to Healthy Eating to intakes of essential fatty acids and vitamins D and E; changes in nutrient profiles of baseline diets conforming to the Australian Guide to Healthy Eating with or without varying amounts of margarines and oils.
Results: ‘Core’ foods and ‘extras’ contributed similar amounts of essential fatty acids and vitamins D and E to the Australian diet, margarines and oils being the major contributor among ‘extras’. The simulated low-fat, low-saturated-fat baseline diets generally failed to meet the adequate intakes for n-3 and n-6 polyunsaturates and vitamin D, and vitamin E in some instances. The addition of 25 g of sunflower margarine, but not comparable amounts of canola margarine, olive oil and butter, markedly increased the ratio of polyunsaturated to saturated fatty acids and generally delivered the adequate intakes, vitamin D being the exception.
Conclusion: The inclusion of margarines and vegetable oils in diets based on the current Australian Guide to Healthy Eating, and guidance on choice among these foods, is required to provide adequate intakes of linoleic acid, α-linolenic acid and vitamins D and E and to achieve fatty acid profiles consistent with the prevention of chronic disease.

Key words: adequate intake, ‘core’ food, dietary modelling, essential fatty acids, vitamin D, vitamin E.

INTRODUCTION
In 1998, the Australian Guide to Healthy Eating (the Guide) was developed to replace the Five Food Groups, which had been the Commonwealth Government’s official food guide for nearly five decades. Impetus for a new food guide came from a need to address diseases of overconsumption in addition to the traditional focus on nutritional adequacy. Six government-funded reports provided the basis for the development of the Guide.1–6

The pictorial version of the Guide depicts five groups of ‘core’ foods recommended for regular consumption and a group of ‘extras’ for consumption sometimes or in small amounts. Supporting literature states that eating a variety of ‘core’ foods ‘. . . is highly likely to result in a diet containing sufficient amounts of all essential nutrients for health’. ‘Extras’, on the other hand, ‘. . . are not essential to provide the nutrients the body needs’. Thus, the distinguishing attribute of ‘core’ foods is their capacity to deliver essential nutrients to the Australian diet.

The positioning of margarines and vegetable oils in the Guide is ambiguous. In the pictorial version margarines and vegetable oils are included in ‘extras’, yet diets based on the
Guide allow a teaspoon of margarine or oil be included per 0.6 of every bread or cereal serve, implying some added fats may add nutritional value to the diet.⁷ Although the supporting literature of the Guide states the main nutritional contribution of fat spreads is vitamin A, margarines also contain linoleic acid, α-linolenic acid and vitamins D and E. ‘Adequate intakes’ for these nutrients were established in the recent Nutrient Reference Values report.⁸ These new recommendations (Table 1) provide benchmarks against which the Guide can be assessed.

The purpose of the present research was:

1. To assess the contribution of ‘extras’, especially margarines and vegetable oils, to the content of linoleic acid, α-linolenic acid and vitamins D and E in the Australian diet.

2. To model the impact of the addition of margarines, butter and olive oil to diets based solely on the ‘core’ food groups on the content of these nutrients.

 METHODS

Analysis of the 1995 National Nutrition Survey

Individual foods on the 1995 National Nutrition Survey (95NNS) database were assigned to either ‘core’ foods or ‘extras’ (including margarines and oils) according to the definitions of the Guide. However, the contribution of margarines and oils used for frying or found in prepared foods (e.g. cakes, biscuits, chips, etc.) was included with the relevant foods. Thus, estimates of the nutritional contribution of margarines and oils are conservative as they refer to their use when eaten ‘as such’, for example spread on bread or crackers, added to vegetables or salads, etc. Composite dishes were categorised according to their 95NNS classification, that is, mixed dishes whose main ingredient was meat or vegetable (e.g. casseroles) were classified as ‘core’, mixed dishes whose main ingredient was cereal (e.g. pies, pastries) were classified as ‘extras’.

The contributions of these two broad categories of foods to population intakes of key vitamins and minerals, essential fatty acids and saturated fatty acids were then assessed using the 24-hour recall data of the 95NNS. The major food database used was that supplied by the Australian Bureau of Statistics in conjunction with the 95NNS Confidentialised Unit Record Files. Vitamin D and vitamin E data were drawn from the United States Department of Agriculture database, amended for known differences between countries (e.g. fortification practices) and supplemented with limited local data available at the time. The fatty acid database used in the analysis included data for more than 1100 Australian foods.⁹

Where the ‘extras’ category was found to contribute significantly to the intake of any nutrients, the contributions of margarines and oils were examined in detail. Finally, the implications of reclassifying margarines and vegetable oils from ‘extras’ to ‘core’ foods on the contribution of ‘core’ foods to intake of essential fatty acids and vitamins D and E were then considered by reanalysis of the data set.

Dietary modelling

A series of low-saturated-fat baseline diets (about 6000–11 000 kJ) was constructed in line with the Guide but without the margarine allowance (Table 2). Different food choices were employed for diets at different energy levels. Four dietary modelling exercises were then conducted adding increasing amounts of fat (10.5 g, 17.5 g and 24.5 g) as either sunflower oil-based margarine, canola oil-based margarine, butter or olive oil to the baseline diets. The choice of spreads modelled reflected the three main segments of the spreads market—polyunsaturated, monounsaturated and dairy-based with the nutrient profile of the margarines being based on typical and currently available products (sunflower spread with 30.0 g polyunsaturated fatty acids per 100 g and n-6/n-3 ratio of 12.0 and canola spread with 15.2 g of polyunsaturated fatty acids per 100 g and n-6/n-3 ratio of 2.9).

The impact on the content of total, saturated and polyunsaturated fat, the ratio of polyunsaturated to saturated fatty acids (P/S), linoleic acid, α-linolenic acid and vitamins D and E was then assessed against the recommended intakes for these nutrients.

RESULTS

Contribution of ‘core’ foods and ‘extras’ to national nutrient intake

‘Core’ foods provided 82–91% of the B group vitamins, vitamin C, iron, calcium and dietary fibre in the Australian
diet, but only 51–69% of linoleic acid, α-linolenic acid, vitamin D and vitamin E, despite providing 57% of saturated fatty acids and 58% of total fat. Among the ‘extras’, the major source of the fat-soluble nutrients in question was margarines and vegetable oils (Table 3). When the margarines and vegetable oils were reclassified as ‘core’ foods, the contribution of ‘core’ foods to the content of these nutrients in the Australian diet increased to 69–80%. Saturated fat increased only marginally, from 57% to 60%.

### Dietary modelling: effects of added fats

Irrespective of the energy level, the baseline diets (without added margarines and oils) were generally low in fat-soluble nutrients, falling short of the adequate intakes for linoleic acid for men and women (all diets), α-linolenic acid for men (five diets) and women (four diets), vitamin D for younger and older adults (all diets) and vitamin E for men (all diets) and women (two diets) (Table 4). As the content of fat-soluble nutrients was low across all baseline diets, the addition of a particular fat produced consistent results across higher- and lower-energy diets. Results of the modelling based on the 6000 kJ baseline diet are reported in detail later and compared with the adequate intakes for linoleic acid, α-linolenic acid, vitamin D and vitamin E for women, those most likely to be consuming this level of energy.

### Essential fatty acids and P/S ratio

Figure 1 shows that the addition of 24.5 g of fat as olive oil to the 6000 kJ baseline diet failed to provide the adequate intakes for n-3 or n-6 polyunsaturates for women. Adding butter produced a similar pattern and the adequate intakes were not met. Although the addition of 15 g of canola margarine (10.5 g fat) was sufficient to comfortably exceed the adequate intake for n-3 polyunsaturates (Figure 2), the provision of n-6 polyunsaturates was limited. Even the addition of 35 g of canola margarine (24.5 g fat) failed to deliver the adequate intake for n-6 for women. When sunflower margarine was added n-3 and n-6 polyunsaturates were provided in ample amounts and in similar proportion relative to the respective adequate intakes (Figure 3). Just 25 g of sunflower margarine (17.5 g fat) was required to provide the adequate intakes for both n-3 and n-6 polyunsaturates.

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**Table 2** Baseline diets: serves of ‘core’ and ‘extra’ foods

<table>
<thead>
<tr>
<th>Cereals</th>
<th>Vegetables</th>
<th>Fruit</th>
<th>Milk</th>
<th>Meats</th>
<th>Extras (a)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approximately 6000 kJ</td>
<td>4</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Approximately 7000 kJ</td>
<td>5</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Approximately 8000 kJ</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Approximately 9000 kJ</td>
<td>7</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Approximately 10 000 kJ</td>
<td>8</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Approximately 11 000 kJ</td>
<td>9</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

(a) Extras in baseline diets were low in fat, for example honey, marmalade, jam, soft drink and wine.

**Table 3** Per cent daily intake of selected fat-soluble nutrients and saturated fat from ‘core’ foods and ‘extras’ of participants in the 1995 National Nutrition Survey

<table>
<thead>
<tr>
<th>Linoleic acid</th>
<th>α-linolenic acid</th>
<th>Vitamin D</th>
<th>Vitamin E</th>
<th>Saturated fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘Core’ foods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat</td>
<td>16</td>
<td>19</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Cereals</td>
<td>14</td>
<td>10</td>
<td>0</td>
<td>8</td>
</tr>
<tr>
<td>Vegetables</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>Nuts/Seeds</td>
<td>6</td>
<td>1</td>
<td>0</td>
<td>4</td>
</tr>
<tr>
<td>Dairy</td>
<td>3</td>
<td>10</td>
<td>26</td>
<td>3</td>
</tr>
<tr>
<td>Eggs</td>
<td>2</td>
<td>1</td>
<td>9</td>
<td>2</td>
</tr>
<tr>
<td>Fish</td>
<td>3</td>
<td>3</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>Total other(a)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>‘Extras’</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Margarines/oils</td>
<td>22</td>
<td>18</td>
<td>20</td>
<td>12</td>
</tr>
<tr>
<td>Cakes/biscuits/pastries</td>
<td>12</td>
<td>14</td>
<td>10</td>
<td>17</td>
</tr>
<tr>
<td>Sauces/condiments</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Potato chips</td>
<td>4</td>
<td>5</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Butter</td>
<td>1</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Non-core dairy</td>
<td>1</td>
<td>2</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Total other(b)</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>5</td>
</tr>
</tbody>
</table>

(a) Legumes, soup, fruit, non-alcoholic beverages.
(b) Snack foods, confectionery, alcoholic beverages, soft drinks.
Figure 4 shows the markedly differing effects on the P/S ratio when comparable amounts of fat from different sources were added to the baseline diet. The low P/S ratio of the baseline diet (0.22) was lowered further by the addition of butter and only marginally increased by adding olive oil. The addition of canola and sunflower margarines increased the P/S ratio in both instances, the effect of sunflower margarine being quite marked—the P/S ratio increasing threefold.

**Vitamins D and E**

The 6000 kJ baseline diet was noteworthy for its low content of vitamin D (0.1 μg). Figure 5 shows the marked difference in effects on vitamin D content when similar amounts of fat in the form of olive oil, butter or margarine were added—the margarines increasing it substantially; butter having a marginal effect and olive oil having no effect. Although the addition of 35 g of margarine (24.5 g of fat) increased the vitamin D content by 2.8 μg and provided more than 95% of the total vitamin D in the resultant diet, the adequate intake for vitamin D was not achieved. The adequate intake for vitamin E was relatively easy to achieve with the addition of the margarines and olive oil, but was not met with the addition of butter.

**Total and saturated fat**

The addition of 17.5 g of fat as sunflower margarine, the minimum necessary to achieve most of the adequate intakes, raised the fat content of the resultant diet to about 28% of energy. This amount of margarine (and olive oil) raised the saturated fat content to 9–11% of energy, consistent with the upper recommended limit of this nutrient. However, the addition of the same amount of fat as butter raised the saturated fat content to 15% of energy, well above the limit.

**DISCUSSION**

By establishing adequate intakes for linoleic acid, α-linolenic acid, vitamin D and vitamin E the Nutrient Reference Values report provided a focus on fat-soluble nutrients that has hitherto been lacking. The analysis and dietary modelling exercise reported here provide an opportunity to assess whether the Guide is consistent with achieving the new targets for these nutrients.

The distinguishing feature of the existing ‘core’ foods in the Guide is their ability to deliver key nutrients in the national diet. In the present study, current definitions of ‘core’ foods and ‘extras’ appeared very effective in discriminating between good and poor dietary sources of water-soluble nutrients, but not fat-soluble nutrients. This shortcoming could largely be attributed to the positioning of margarines and vegetable oils as ‘extras’. When margarines and vegetable oils were reclassified as ‘core’ foods the contribution of ‘core’ foods to intakes of the fat-soluble nutrients in question in the Australian diet rose substantially.

Several reports recommending desirable levels of linoleic acid and α-linolenic acid in the Australian diet have been...
The Nutrient Reference Values report provides two targets for these fatty acids—the first relates to the provision of adequate intakes; the second, more challenging target is consistent with the prevention of coronary heart disease. None of the low-fat, low-saturated-fat baseline diets in the present study provided the adequate intakes for both essential fatty acids, suggesting that margarines and vegetable oils, or foods providing similar nutrients, need to be included. Effects on essential fatty acid content differed markedly following the addition of the alternative fats, with the sunflower margarine proving to be the best option. Adding canola margarine to the model did deliver the adequate intakes but at higher levels of total fat and kilojoules than sunflower margarine. Although the failure of butter to achieve the adequate intakes for the essential fatty acids was expected, the failure of moderate amounts of olive oil to provide these nutrients provides food for thought. The popularity of olive oil and the upward trend in ‘olive’ margarines and dairy blends in the Australian and New Zealand markets would appear to have potential for adverse effects on intakes of essential fatty acids, especially linoleic acid.

The target intake for polyunsaturated fatty acids for the prevention of coronary disease is 5–10% of energy. When considered in conjunction with the upper recommended intake for saturated fatty acids (10% of energy), this target may be expressed as a P/S ratio of 0.5–1.0. At similar levels of total fat intake, P/S ratios in this range would be expected to be associated with lower serum cholesterol concentrations and lower risk of coronary heart disease than the current P/S of the Australian diet of 0.36. P/S ratios in the low-fat, low-saturated-fat baseline diets constructed for the present study were low, typically about 0.4, and this was
largely due to low content of polyunsaturated fatty acids. The effect of fat addition on P/S ratio was highly dependent on the choice of spread or oil—both margarines increased the P/S ratio, the sunflower margarine having the greater impact; olive oil had little effect; and butter had a negative effect. Even with the optimal choice, a moderate rather than low intake of total fat was required to achieve a high P/S ratio. As high P/S ratios are consistent with high intakes of

**Figure 3** n-3 and n-6 polyunsaturated fatty acids (PUFA) when sunflower margarine is added to 6000 kJ baseline diet. Al, adequate intake.

**Figure 4** Ratio of polyunsaturated to saturated fatty acids (P/S) when butter, olive oil, canola margarine and sunflower margarine are added to the 6000 kJ baseline diet.

**Figure 5** Vitamin D content when butter, olive oil and margarines are added to the 6000 kJ baseline diet.
essential fatty acids and vitamin E, as well as protection against coronary disease, the ratio appears to be a better measure of fat quality than saturated fat alone.

It is often assumed that energy restriction for weight management should be associated with a low per cent of energy from fat and that, as the Guide states, ‘... extra foods should be kept to a minimum’ during weight reduction. Neither assumption was supported by the present dietary modelling exercise. Low-energy diets based on the ‘core’ foods without added fats did not provide the adequate intakes for fat-soluble nutrients. Second, it was mathematically inevitable that, when a fixed amount of fat was added to the 6000 kJ, 7000 kJ and 8000 kJ baseline diets, the lowest-energy diet had the highest per cent of energy as fat. Although an ‘acceptable’ range of fat intakes of 20–35% of energy has been suggested in the Nutrient Reference Values report, it may be advisable to recommend low-energy diets contain at least 25% of energy from fat. Even then, nutrient adequacy will largely depend on the inclusion of foods containing the more nutrient-dense, polyunsaturated fats.

In recent years evidence of vitamin D deficiency in a number of high-risk groups in Australia has accrued, which in turn led to the establishment of a dietary target for this nutrient. In the present study none of the low-fat, low-saturated-fat baseline diets based on the Guide provided the adequate intakes for vitamin D for younger or older adults. Of the added fats, only the margarines provided appreciable vitamin D, the quantity suggesting this food source can realistically provide 40–50% of the adequate intake for younger adults. Emphasis on other food sources of vitamin D, such as oily fish, and further fortification of staple foods may be required if the adequate intakes for vitamin D are to be met, particularly those for older age groups.

It could be argued that existing core foods in the Guide, such as nuts and seeds, have the potential to provide substantial amounts of fat-soluble nutrients. However, although some nuts and seeds are rich in linoleic acid and vitamin E, they are generally poor sources of α-linolenic acid and lack vitamin D. Second, nuts and seeds are minor components of the Australian diet, with combined consumption of 5 g/day and 3 g/day for men and women, respectively, in 1995. The data from the 95NNS reported here indicate that nuts and seeds provided only 6% of linoleic acid, 1% of α-linolenic acid, 4% of vitamin E and no vitamin D. As outlined later, the current positioning of nuts and seeds in the Guide, in the meats and alternatives food group, may need to be reconsidered. Any choice of nuts and seeds in preference to foods of animal origin would come at a considerable cost to bioavailable iron, zinc and vitamin B-12.

A ‘healthy fats’ group?

Among the major sources of fat in the Australian diet margarines and oils is the only group of foods that is relatively low in saturated fats and rich in essential fatty acids, vitamin D and vitamin E. To facilitate adequate intakes of these nutrients in the context of diets low in saturated fat and moderate in total fat, food guides need to provide clear, unequivocal advice about these fat-rich foods. By grouping trans-free margarines and oils with foods relatively high in saturated fat and low in essential fatty acids, the Guide does not serve this end. If low-saturated-fat diets that meet the adequate intakes for essential fatty acids and vitamins D and E are difficult to construct without margarines and oils then consideration should be given to including them as ‘core’ foods in any revision of the Guide. One possibility would be for margarines and oils to be grouped with foods that share these distinguishing nutrients, such as nuts and seeds, in a ‘healthy fats’ group. In general, implications for dietary energy would be minimal as the amount of margarine and oil recommended would be similar to that already recommended in Guide but not communicated through its pictorial version.

CONCLUSION

One of the aims of the Guide is to achieve a balance between the modern imperative of preventing chronic disease and the more fundamental role of food guides—to ensure the provision of adequate amounts of all essential nutrients. The analyses and dietary modelling reported here suggest that, in the light of current evidence and recommendations, the Guide does not achieve this balance.

Trans-free margarines and vegetable oils are low-saturated-fat sources of essential fatty acids and vitamins D and E in the Australian diet. Diets based on the ‘core’ food groups of the Guide, without margarines and oils, are unlikely to contain the adequate intakes for these nutrients, even at high energy levels. The addition of moderate amounts of margarines and oils to such diets facilitates significant increases in content of linoleic acid, α-linolenic acid and vitamins D and E and meets the adequate intakes of these nutrients in most cases, vitamin D being the exception. Furthermore, choice among added fats is crucial to achieving fatty acid profiles consistent with the prevention of coronary heart disease. If ‘core’ foods are defined by their ability to deliver essential nutrients in the Australian diet, within the context of overall dietary balance, then trans-free margarines and oils deserve consideration as ‘core’ foods and could be grouped with nuts and seeds in a ‘healthy fats’ food group.

REFERENCES

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