Meeting nutrient and energy requirements in old age

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Abstract

In old age, the complex relation of food consumption with energy and nutrient requirements finds expression in both single and multiple nutritional problems. Addressing conditions affecting intake — either from foods or from supplements — endogenous production, bioefficacy and/or requirements can benefit nutritional health in old age through balancing requirements and supply. © 2001 Elsevier Science Ireland Ltd. All rights reserved.

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1. Introduction

The definition of ‘old age’ is currently a matter of debate. For enforced retirement, it is often set at 65 years. At this age, men and women in developed countries have a life expectancy of 15–20 years [1]. The evidence to date suggests that improvements in nutrition — next to changes in other lifestyle factors — would help to make these years healthier, more active and less dependent on others [2].

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2. Efficacious supply of energy and nutrients

In old age, many factors come into play to ensure adequacy of the energy and nutrient supply (Fig. 1). In order to maintain homeostasis, diets should provide all the essential nutrients and sufficient energy to balance individual requirements. Traditionally, unmodified foods are the major sources of energy and nutrients. Scientific and technological advances have made it possible to modify existing foods or to formulate new foods. When appropriately modified by increasing nutrient content or bioefficacy (see below), such foods can be nutritionally advantageous to the elderly population, since elderly people are considered at increased risk for nutrient deficiencies...
Fig. 1. Meeting nutrient and energy requirements.

3. Nutrient and energy requirements

The question arises as how best to define nutrient requirements in elderly people. Biochemical standards, which are often extrapolated from studies in younger people, may no longer suffice as the gold standard for nutrient requirements. This is because interest has shifted from the amount required to prevent signs and symptoms of deficiency to the amount required to prevent chronic diseases and to optimise function.

An understanding of the physiological changes that occur in association with ageing is needed to quantify the impact of these changes on nutritional requirements. Examples of such changes are age-related alterations in gastrointestinal function. However, compared to the magnitude of basic requirements, their impact is generally not great [5]. The most prominent effect of ageing on gastrointestinal function is in the stomach. The physiological consequences of the hypochlorhydria resulting from atrophic gastritis are summarised in Table 1[6]. For example, elderly people
with atrophic gastritis have poor absorption of protein-bound vitamin B12 but normal absorption of crystalline vitamin B12 [7]. Although most of the consequences, including decreased nutrient bioavailability and increased risk of bacterial overgrowth of the small intestine, are negative, increased bacterial synthesis of folate and vitamin B6 is a positive aspect. In addition, nutritional deficiencies may arise from effects of disease not directly involving the gastrointestinal tract. These include disease-induced anorexia resulting in decreased food consumption and disease-induced increased energy expenditure together with increased utilisation and excretion of various nutrients.

Drug therapy may have iatrogenic effects on nutritional status (Table 2)[8]. In relation to Fig.

### Table 1
Effects of hypochlorhydria on nutrient bioavailability and endogenous synthesis [6]

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Bioavailability</th>
<th>Mechanism(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium</td>
<td>Decreased</td>
<td>Decreased solubility</td>
</tr>
<tr>
<td>Iron</td>
<td>Decreased</td>
<td>Decreased solubility, decreased absorption of non-haem-iron</td>
</tr>
<tr>
<td>Folate</td>
<td>Decreased</td>
<td>Decreased absorption</td>
</tr>
<tr>
<td>Vitamin B6</td>
<td>Decreased</td>
<td>Decreased digestion</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>Decreased</td>
<td>Decreased digestion and absorption of protein-bound vitamin, increased bacterial uptake</td>
</tr>
</tbody>
</table>

4. Food intake, quantity and quality

Population-based nutritional surveys have shown that there is a gradual decline in energy intake with increasing age [10]. From the age of 70 years, changes related to ageing appear to be small among rather healthy elderly Europeans [11–13]. Studies in Europe have revealed considerable differences in food cultures within Europe [11,12]. An increased probability of surviving 5 years after the age of 70 years was found to be related to consuming diets resembling the Mediterranean pattern [14,15]. Important characteristics of such a diet appear to be: (1) a high contribution of olive oil providing a high ratio of mono-unsaturated to saturated fatty acids even with a total fat intake of about 40 energy% [16]; (2) a relatively high intake of omega-3 fatty acids, which are now believed to play a role in the improvement of blood lipid parameters, blood clotting, arthritis and depression; (3) a high intake of plant foods, which are good sources of several nutrients such as folate and vitamin B6, which are at risk of deficiency in older adults.

In addition to a wise choice of food types, sufficient energy intake related to sufficient food intake appears to be necessary to achieve adequate intake of nutrients [17,18]. In a comparative study in the Netherlands, physically active elderly
women living at home were shown to have higher energy intakes (8.8 ± 2.2 MJ/day) than more sedentary elderly women living at home (7.7 ± 2.3 MJ/day) or in a nursing home (6.5 ± 1.2 MJ/day). At the same time, no clear differences in food consumption patterns were seen between the free-living and nursing-home elderly [19], which points to the importance of sufficient food intake, or early vigorous treatment of malnutrition. Especially if older adults have low energy intakes, it is important that the foods they eat be dense in energy and in nutrients.

5. Energy intake and regulation

Low levels of physical activity and decreased basal metabolism accompany older age. Thus, less energy is required to balance energy intake and requirements [20]. When present, disease generally reverses the decline in basal metabolic rate, but the concurrent reduction in physical activity tends to keep energy requirement low [21]. Over the age of 70 years, negative energy balance is common and may lead to weight loss and ultimately malnutrition. Among the hospitalised elderly, as many as 37% are reported to be malnourished [22]. Their energy intake (6.0 ± 0.9 MJ/day) has been found to be 1.7 MJ/day below that of their free-living ‘apparently healthy counterparts’ [10].

Studies with doubly labelled water suggest that, relative to the recommendations, ‘healthy’ elderly people may have increased energy requirements. At the same time, they exhibit a profound loss of ability to control energy intake [23]. In addition, taste sensitivity declines substantially with age [24]. The combined loss of homeostatic control and taste sensitivity generally leads to a reduced desire to eat food, which, together with increased energy requirements, often results in a downward spiralling negative energy balance.

6. Nutrients at risk of deficiency

Even with an apparently adequate food intake, an adequate supply of some nutrients is hard to achieve. Atrophic gastritis, which reduces the absorption of food forms of vitamin B<sub>12</sub>, as discussed above, is prevalent in elderly people, affecting 32% of 74–80 year olds in the Netherlands [25]. However, the high prevalence (24%) of mild vitamin B<sub>12</sub> deficiency in these older subjects could only be explained in part (28%) by inadequate vitamin B<sub>12</sub> intake or severe atrophic gastritis. As yet, there is no evidence that vitamin B<sub>12</sub> is handled differently in old age once the vitamin is absorbed. Therefore, other factors responsible for the cobalamin deficiency need to be sought.

Through its role in reducing elevated homocysteine concentrations, vitamin B<sub>12</sub> is closely related to folate and vitamin B<sub>6</sub>. An elevated risk of cardiovascular diseases related to high homocysteine levels emerged from a 10-year follow-up of 878 elderly men in the Dutch cohort of the Seven Countries Study [26]. Moreover, associations between cognitive function and intakes of vitamin B<sub>6</sub> [27], folate [28] and vitamin B<sub>12</sub> [27] have been found. Mechanisms linking vitamin status, homocysteine levels and cognitive function require further study.

There is evidence that older adults may have a greater need for vitamin D because of a reduced capacity to synthesize provitamin D<sub>3</sub> in skin and to hydroxylate vitamin D<sub>3</sub> in kidneys. This is accompanied by a tendency for reduced sun exposure [29], which, together with the reduced synthetic capacity, leads to the reduced ‘endogenous nutrient/energy’ supply referred to in Fig. 1. As Western diets generally provide 25–50% of the current recommended vitamin D intake, supplementation at old age would appear to be necessary for bone health, even though the amount of vitamin D required to prevent bone demineralisation is still a matter of debate.

Based on current knowledge, requirements for vitamin C in older people do not differ from those of younger people (60–100 mg/day). It should also be remembered that vitamin C (ascorbic acid) increases the absorption of non-haem iron (the E from SLAMENGHI). Unfortunately, vitamin C is readily lost from foods during storage and preparation [18]. For Dutch and Danish diets, losses average about 55%.
7. Possible interventions to achieve balance

Both in the healthy elderly and in geriatric patients, it is important to ensure that a balance between supply of and requirements for nutrients and energy is achieved. Specific measures could address energy and nutrient intake, endogenous nutrient production, bioefficacy and nutrient requirements.

7.1. Food approaches to increasing energy and nutrient intake

Recently, several well-controlled studies have demonstrated positive effects of various dietary and psychosocial interventions in hospitalised, institutionalised and frail elderly people. These include providing nutrient dense modified foods to improve biochemical parameters of nutrient status and parameters of bone health [30,31] and improving the psychosocial environment to counteract the downward spiral of geriatric failure to thrive (Matheij, unpublished observation). Increased intake of energy arising from increased energy expenditure as a result of training has been shown to be a way of improving overall nutritional intake in old age [32]. Furthermore, there is evidence that significant improvements in nutrient status and reductions in case fatality rates occur when supplements rich in protein and energy are given routinely to adults >70 years [33]. Food consumption can also be increased by providing foods with organoleptic properties optimal for the elderly. In addition, the nutrient, food and meal-related bioefficacy factors can also be optimised. Of the SLAMENGHI factors, these are the ‘S’ for species of nutrient, ‘L’ for molecular linkage, ‘M’ for matrix and ‘E’ for effectors of bioavailability and bioconversion. Carotenoid bioavailability and conversion to retinol can be substantially increased by altering the food matrix (‘M’ [4]), while the bioavailability of non-haem iron can be increased by reducing the concurrent ingestion of phytates and tannins and increasing the concurrent ingestion of ascorbic acid (‘E’ [34]).

7.2. Nutraceutical approaches to increasing nutrient intake

In order to avoid specific nutrient deficiencies in elderly people with an adequate energy intake, provision of nutrient supplements may be useful as an alternative to increasing the intake of modified (fortified or bioefficacy-improved). Such supplements should contain those nutrients most at risk of deficiency such as vitamin D and vitamin B₁₂ [25,35]. The nutraceuticals should provide optimal conditions for the absorption/bioconversion of nutrients with respect to the first five SLAMENGHI factors: species, metabolic linkage, amount, matrix and effectors. Generally, these supplements are low in energy.

7.3. Increasing nutrient intake through endogenous production

It appears that 10–20 μg of vitamin D/day are needed in elderly people in order to assure optimal bone health. Since 25-hydroxy vitamin D concentrations are affected by the duration and intensity of exposure to sunlight, ‘going outside when the sun shines’ does improve endogenous vitamin D production and helps to ensure adequate vitamin D status.

7.4. Reducing the adverse effects of host-related factors influencing bioefficacy

Consequences of atrophic gastritis include limiting the bioavailability of vitamin B₁₂ due to impaired cleavage of vitamin B₁₂ from food protein and peptides, limiting the absorption of folic acid and impairing the absorption of calcium carbonate (Table 1). Controlling atrophic gastritis — which is largely related to eliminating Helicobacter pylori — would be a way to limit its adverse effects on vitamin and mineral absorption.

7.5. Influencing requirements by reducing losses of nutrients and energy

Care should be taken to reduce the pathological and iatrogenic losses of nutrients. This re-
quires the responsible use of drugs to reduce the adverse effects of disease without introducing excessive iatrogenic effects not only from the use of single drugs but also from regimens involving the combined administration of drugs.

8. Concluding remarks

Especially in the frail, early interventions are considered crucial for preventing the progression of malnutrition. Thus, all physical, social and psychological conditions that may lead to failure to thrive should be identified and addressed. Intervention studies in healthy elderly people are required in order to obtain a better understanding of the patho-physiology of chronic conditions that lead to progressive functional decline in old age.

References


Discussion

Naftolin:
Did you correct for hormone replacement use? What do you think of its role?

De Groot:
We do not have information on that. We do have blood samples in our freezer from 10 years ago. They can be analyzed as soon as we know what to do with them, but so far we have not worked on that.

Naftolin:
In many experimental situations and some clinical situations it has been shown that hormone replacement affects the absorption of food.

Thijssen:
You should realize that the incidence of hormone replacement in The Netherlands is low and especially in the population studied, where it is lower than 10%.

De Groot:
We have information on the use of drugs, we can still have a look.

Morley:
In your interventional study, you used energy-dense foods. As we get older, we have problems with the ability of the stomach to comply with highly dense food to take them in. Have you tried in any of your other studies using liquid supplements, particularly between meals that would give you a greater energy intake particularly in the exercising group?

De Groot:
These products were not energy-dense, they were regular products used by elderly people in normal life, enriched especially for this study, with the same volume and weight.

Ropers:
I was somewhat alarmed by the high rate of atrophic gastritis, around 25% in the elderly. Is that common knowledge, does it improve, can it be treated?

De Groot:
It is indeed a problem that is highly prevalent in elderly people. The treatment should be a combination of drugs. There are various types of atrophic gastritis, but I do not know how successful the treatment will be and whether it recurs again when treatment is stopped.

Ropers:
You assessed it during the study but there was no follow-up. When was this assessed?

De Groot:
This was assessed in the Dutch cohort of the SENECA-study, it was not adjusted.

Morley:
The prevalence is similar to that in the United States; it might be due to a lifetime infection. Treatment does not necessarily make a difference to the outcome, but we do not have a good treatment at the moment.