Original Communication

The Role of Vitamins in Aging Societies

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Abstract: Raising numbers of elderly lead to a dramatic shift in demographics, accompanied by an increase in non-communicable diseases such as cancer, cardiovascular disease and dementia. All these conditions are thought to be modifiable by diet to some degree and mounting evidence indicates that improved intakes of certain vitamins can slow their progress. Strong evidence exists for the beneficial effect of vitamin D on the risk of bone fractures. Moreover, as chromosomal damage is a risk factor for dementia, supplementation with nutrients preventing these impairments are thought to have a beneficial effect on cognitive decline. However, the aging progress strongly affects nutrient intakes and utilisation due to social, physical and psychological changes. Data from dietary surveys suggest that many of the elderly in Europe have intakes for various vitamins that are well below the recommendations. The situation appears to be even more critical for elderly in institutions such as care homes. Given the increasing number of elderly and the importance of an adequate supply with vitamins, more research is warranted to find nutritional solutions to improve their wellbeing and health – which in the long run can be expected to contribute to reduce the ever increasing health care costs.

Key words: vitamin, aging, elderly, non-communicable diseases, inadequate intake

Century of aging and its consequences

Based on current estimates, in 2040, more than one in four European will be ≥ 65 and one in seven ≥ 75 years [1]. The 21st century was coined the *century of aging* as life expectancy increased during the past 100 years by >30 years due to declining mortality rates, which lead, combined with reduced fertility rates, to a dramatic shift in demographics [2]. As a result of this global phenomenon, non-communicable diseases (NCD) such as cardiovascular diseases, dementia and cancer are becoming more prevalent [1]. This is reflected in the 8 to 10 years difference between health and life expectancy, indicating that the last decade of life is marked by an increasing rate of disability [2]. Due to their chronic nature, NCD place a heavy burden on the economy, affecting increasingly also low and

middle income countries [3]. This means demand for health and long-term care as well as expenses for pensions and social security will increase [4]. Moreover, the prolonged illness also leads to a reduction in the quality of life [5].

Nutrition plays an important role in maintaining health throughout the lifecycle: According to the Institute of Medicine, “*nutrition is a key component to promoting healthy and functional living among older adults* [6]”. Bruce Ames formulated the so-called triage theory, which postulates that during times of nutritional scarcity, evolutionary priority was given to short-term survival at the expense of damage evident in older age [7]. Mounting evidence indicates that some of these adverse effects can be countered by adequate nutrition.

In elderly women in nursing homes, for example, supplementation with vitamin D and calcium de-

creased the risk of falling by 49 % compared to calcium supplementation alone [8]. It also led to a reduction in body sway, a risk factor for hip fractures, by 9 % [9]. A recent meta-analysis including >31.000 persons >65 years reported a 30 % reduction of hip fractures and a 14 % decrease of any non-vertebral fracture in the group with a median daily intake of 800 International Units (IU) vitamin D [10]. Consequently, it is now widely recommended that all postmenopausal women and men over the age of 60 should receive at least 800 IU of vitamin D supplements per day to minimise the risk of falls and fractures [11]. This was recently acknowledged in an EFSA claim [12]. However, vitamin D deficiency is thought to be widespread among the elderly due to reduced production in the skin and renal insufficiency [13] as well as decreased absorption due to a reduced number of vitamin D receptor in the intestine [14].

Impact of aging on micronutrient intake and utilisation

Age and the often closely linked pathologies result in a multitude of physiological and social changes that affect food intake and utilisation. Decreased income after retirement, lack of mobility and social contacts lead to a decrease in food intake [13]. The decline in the effectiveness of detecting and reacting to hunger makes the elderly particularly vulnerable to malnutrition [15]. Moreover, appetite decreases due to declining taste and smell sensitivities, various pathological conditions or medications and impaired chewing due to ill-fitting dentures [16].

The efficiency of the stomach is often impaired due to decreased secretion of gastric acid, pepsin and mucus as well as a reduction in gastric emptying and blood supply [17]. Malabsorption is often a result of surgery or pathologic conditions such as Crohn's, Whipple's or celiac disease, infections with *Helicobacter pylori*, alcoholism or certain infections [17–19]. With age, the gut microbiota shifts towards an increase in enterobacteria at the cost of anaerobes and bifidobacteria, which increases the vulnerability to diarrhoeal diseases [20]. At the same time, constipation is widespread due to lack of exercise, dehydration, a diet low in dietary fibre and drug treatment [21].

While body mass increases from early adulthood to about 70 years mainly due to increase in visceral and subcutaneous fat, it decreases afterwards as lean mass and some subcutaneous fat is lost [22]. A decrease in circulating hormones involved in muscle metabolism

and damage due to oxidative stress and inflammatory processes affecting fat and protein metabolism further contribute to the loss of muscle tissue [23]. Whether caused by voluntary or involuntary factors, these changes were found to be associated with increased risk for malnutrition [22]. It is therefore thought that optimising food quality and increasing level of physical activity can improve nutrient status of elderly nursing home residents [24].

Micronutrients and non-communicable disease

Of the 10 leading causes of death, the six most important ones are NCD accounting for 70 % of deaths in the ≥65 years old in the US [25]. According to WHO, 36 out of 57 million global deaths in 2008 were due to NCD and 80 % of premature heart disease, stroke and diabetes can be prevented by modifying factors such as nutrition [26]. Due to the multifactorial nature of factors affecting the development of NCD and their long latency period, it is difficult to establish a clear cause-effect relationship between nutrition and chronic diseases [27]. Much of the evidence is derived from epidemiological studies as randomised control trials (RCT) are often not practical due to the long latency period of the effect and the ethical problems using no or insufficient intakes of nutrients as a 'true' placebo controls [28]. Due to these and a host of other reasons, the evidence from RCT is considered inconsistent. However, a recently published RCT with a follow-up of more than a decade showed that long-term supplementation with multi-micronutrients led to a significant reduction of overall cancer risk by 8 % [29]. According to the authors, effects in the same subjects on the risk for cardiovascular events, eye diseases and cognitive decline will be published separately. The mounting evidence of the beneficial effect of various dietary interventions with micronutrients or associations thereof with health outcomes makes a strong case for the importance of micronutrients at old age.

Micronutrients and cognitive functions

Even though a strong correlation exists between aging and dementia, it is clearly a pathological condition caused by various genetic and environmental factors, including nutritional components [30]. It is thought

Figure 1: Elderly (65–80 years) in Germany with intakes below the specific recommended reference value for men (n= 1469) and women (n= 1562) [42]. • <5 %, • 5 % to 25 %, • >25 % to 50 %, • >50 % to 75 % and • >75 % of DACH recommendations [43, 44].

Figure 2: Institutionalised elderly (≥65 years) in Germany with intakes below the specific recommended reference value for men (n= 148) and women (n= 606) [40]. • <5 %, • 5 % to 25 %, • >25 % to 50 %, • >50 % to 75 % and • >75 % of DACH recommendations [43, 44].

that there is an association of increased homocysteine alone or combined with decreased levels of folate, vitamin B₆ and/ or B₁₂ and the development of dementia [30]. Low vitamin B₁₂ status was connected with cognitive dysfunction [31], which improved with supplementation [32]. Chromosomal damage is associated with accelerated ageing and neurodegenerative diseases [33, 34]. Consequently, the impact various nutrient deficiencies are thought to have on the chromosomes, is likely affecting the development of dementia [35]. A recent meta-analysis found evidence that supplementation with multivitamins reduces the odds of cognitive decline, potentially also linked to the development of Alzheimer's disease [36]. Multivitamins were reported to slow down the progression of cognitive decline in elderly women [37]. Moreover, increased intakes of vitamins were also linked to alertness, general well-being and a reduction in negative mood-swings in elderly men [38]. Finally, in an RCT, high doses of folic acid, vitamin B₆ and B₁₂ were shown to significantly reduce the rate of age-related loss of brain tissue in elderly (>70 years) with cognitive impairments [39].

What do we know about micronutrient intakes in the elderly?

Data collected in the frame of a recent German nutrition survey shows that intakes for several vitamins are inadequate in the elderly (Figure 1). While vitamin D and folic acid appear to be the most critical, vitamin

E and C are low in up to half the elderly. Moreover, these data do not take into account reduced absorption of vitamins due to aging, but also concurrent diseases. The situation becomes even more critical when assessing the vitamin intakes of institutionalised elderly [40] (Figure 2). Similar results were reported in a recent report on the benefit of oral nutritional supplements for the elderly [41]. The authors concluded that the issue of malnutrition in the elderly needed to be addressed urgently and that nutritional interventions were shown to improve health outcomes and to be cost effective.

Conclusions

The rapid demographic shift we are witnessing is a global phenomenon and the resulting consequences, in particular for the growing segment of the elderly, are a challenge. As physiology changes with aging, the nutritional needs do too! A number of studies report benefits on various health outcomes of micronutrients including on cognition, cardiovascular disease and cancer. On the other hand, it is alarming that the micronutrient intake in significant parts of the elderly is well below current intake recommendations. We think this field of research should be given much more attention as there is encouraging evidence that an appropriate micronutrient status will contribute to wellbeing and health outcomes in the elderly – which can also be expected to help to reduce the ever increasing health care costs.

Abbreviations

IU International Units

NCD non-communicable disease

RCT randomized controlled trial

References

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