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# Conventional foods, followed by dietary supplements and fortified foods, are the key sources of vitamin D, vitamin B6, and selenium intake in Dutch participants of the NU-AGE study

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ABSTRACT

With aging, energy needs decrease, necessitating a more nutrient-dense diet to meet nutritional needs. To bridge this gap, the use of nutrient-dense foods, fortified foods, and dietary supplements can be important. This observational study aims to describe current micronutrient intakes of Dutch elderly and to identify the contribution of nutrient-dense foods, fortified foods, and dietary supplements to the intake of micronutrients that are often inadequately consumed in Dutch elderly. Data of 245 Dutch volunteers from the NU-AGE study aged 65 to 80 years were used. Dietary intake was assessed by means of 7-day food records, and dietary supplement use was recorded with an additional questionnaire. Information on fortified foods was obtained from the Dutch Food Composition Table 2011. Nutrient density of foods was evaluated using the Nutrient Rich Food 9.3 score. The percentages of participants not meeting their average requirement were high for vitamin D (99%), selenium (41%), and vitamin B6 (54%) based on conventional foods and also when taking into account fortified foods (98%, 41%, and 27%, respectively) and vitamin and mineral supplements (87%, 36%, and 20%, respectively). Conventional foods were the main source of vitamin D, vitamin B6, and selenium intake (42%, 45%, and 82%, respectively), followed by vitamin and mineral supplements (41%, 44%, and 18%) and fortified foods (17%, 11%, and 1%). Foods with the highest nutrient density contributed most to total vitamin B6 intake only. To optimize nutrient intakes of elderly, combinations of natural food sources, fortified foods, and dietary supplements should be considered.



*Abbreviations:* AR, average requirement; BMI, body mass index; DNFCS, Dutch National Food Consumption Survey; ILSI Europe, European branch of the International Life Sciences Institute; LIM3, 3 nutrients to limit; MDV, maximum daily value; MVMM, multivitamin multimineral; NEVO, *Nederlands Voedingsstoffenbestand*; NR9, 9 nutrients to encourage; NRF9.3, Nutrient Rich Food 9.3; RDV, recommended daily value; UL, upper intake level.

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## 1. Introduction

Similar to several other developed regions of the world, the European population is aging rapidly. It is expected that approximately 30% of the European population will be 65 years or older by the year 2050 [1]. With aging, energy needs decrease while micronutrient requirements remain or increase, necessitating a more nutrient-dense diet to meet nutritional needs [2]. Inadequate nutrient intake may cause chronic metabolic disruption, including mitochondrial decay, resulting in acceleration of various degenerative diseases [3]. The prevalence of malnutrition and undernutrition is relatively high in both institutionalized (40%-65%) and noninstitutionalized elderly (5%-10%) [2]. In Europe, more than 20% of the people aged 65 years and older have inadequate intakes of vitamin D, folate, calcium, selenium, and iodine [4] and intakes of vitamin D, calcium, selenium, magnesium, thiamine, and riboflavin are of possible public health concern [5].

These findings are in line with EURRECA outcomes for priority nutrients. EURRECA was an EU 6th Framework Program–funded Network of Excellence, aimed to align the micronutrient recommendations in Europe. EURRECA identified 10 priority micronutrients for elderly (vitamin D, folate, vitamin B12, vitamin C, iron, calcium, zinc, selenium, iodine, and copper) based on heterogeneity in current recommendations, amount of new evidence, and importance for public health [4].

Sources of micronutrients include conventional foods, fortified dietary sources, and vitamin and mineral supplements. The intake of micronutrients can be limited resulting in nutrient inadequacies or deficiencies in the population. Over the last few decades, the consumption of nutrient-rich conventional foods (eg, whole grains, vegetables, and low-fat dairy products) has been partially shifted toward the consumption of nutrient-poor but, at the same time, energy-dense foods (ie, food with a high content of added sugar or solid fats) [6]. This shift in food consumption patterns could be considered as another important factor of the observed insufficient dietary intakes of micronutrients.

Widespread nutrient intake shortfalls and associated deficiencies can be prevented or improved not only by means of nutritional advice on consumption patterns but also by using fortified foods [7]. Fortification is the process of adding nutrients or nonnutrient bioactive components to foods [7]. Food fortification could be considered a public health strategy to enhance nutrient intakes of a population. In addition, dietary supplements can effectively counteract inadequate nutrient intakes and its consequences [3]. Besides estimating inadequate nutrient intakes, it is also important to take into account the possibility of excessive nutrient intakes as the availability of food fortification and dietary supplement intake increases [8].

This study aimed to describe current dietary intakes compared to nutritional requirements in Dutch elderly who were part of a cohort study and to explore which component—for example, conventional foods, fortified foods, or dietary supplements—is the main contributor to total dietary intakes of elderly. Because not much is known on how to classify conventional foods consumed by elderly based on their nutrient content, this study additionally aimed to explore if a concept of nutrient density can be used when studying the contribution of nutrient-dense foods to total dietary intakes.

We hypothesized that, by knowing how conventional foods, fortified foods, or dietary supplements differ in their contribution to total dietary intakes, dietary advices can be targeted toward bridging the gap between dietary intakes and nutritional needs in elderly. Therefore, the objectives of this present study were (1) to estimate dietary intakes from conventional foods, fortified foods, and dietary supplements; (2) to compare these intakes to nutritional requirements of the elderly; and (3) to explore the use of a nutrient density score in this respect.

## 2. Methods and materials

### 2.1. Study design and population

The present study was commissioned by the Nutrient Intake Optimisation Task Force of the European branch of the International Life Sciences Institute (ILSI Europe). Baseline data from Dutch NU-AGE participants were used. The NU-AGE study is a dietary intervention study among volunteers aged 65 years and older living in the Netherlands, the United Kingdom, Italy, Poland, and France [9] that focuses on the effect of nutrition on inflammaging, that is, chronic low-grade inflammation, and its consequences on the aging process [10]. The NU-AGE dietary intervention study is a 1-year randomized, single-blind, controlled, parallel trial consisting of a control group and a diet group. The dietary intervention is specifically adapted to the nutritional needs of elderly and is described in detail elsewhere [9].

A total of 252 apparently healthy and independently living men and women, aged 65 to 80 years, were recruited from the Dutch city of Wageningen and surroundings. Exclusion criteria were overt diseases, history of severe heart disease, organ failure, insulin-dependent diabetes mellitus, chronic use of corticosteroids or recent use of antibiotics, undernourishment (body mass index [BMI], <18.5 kg/m$^2$), and frailty. A screening questionnaire was used to verify current health, medical history, and medication use. The presence of frailty was assessed with a test described by Fried et al [11]. The NU-AGE study has been approved by the Medical Ethical Committee from Wageningen University (NL37818.081.11), and all participants provided written informed consent. The baseline examinations started in April 2012 and continued until March 2013. Participants were visited by trained dieticians once to complete dietary and supplement intake data. Participants completed a questionnaire to collect information on lifestyle, social and economic status, food preferences, and a supplement questionnaire. In the present study, we excluded participants who had not completed the supplement questionnaire (n = 7), resulting in a population for analysis of 245 participants.

### 2.2. Dietary intake assessment

#### 2.2.1. Micronutrient intake from foods

Usual dietary intake was assessed by means of estimated food records [12] that were kept for 7 consecutive days. Participants received both verbal and written instructions to keep

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