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Micronutrient Deficiencies in Later Life: When Food Abundance Does not Guarantee Adequate Nutrition

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ABSTRACT

Population ageing is changing the clinical meaning of malnutrition. Older adults may live in environments characterized by abundant food, yet simultaneously experience inadequate intake or status of several vitamins and trace elements. The paradox is particularly relevant because energy requirements generally decline with age whereas requirements for many micronutrients do not decrease proportionally. A diet that is adequate in calories can therefore remain inadequate in micronutrient density. Age-related anorexia, altered taste and smell, dental and swallowing problems, social isolation, reduced mobility, poverty, multimorbidity, polypharmacy, gastrointestinal disease and impaired absorption can progressively narrow dietary diversity. Contemporary food environments may amplify this vulnerability when inexpensive, convenient and energy-dense products displace nutrient-dense foods. Vitamin B12 (cobalamin) provides a clinically important model. In older adults, deficiency may result from low intake, food-cobalamin malabsorption, atrophic gastritis, pernicious anemia, gastrointestinal disorders or medication-related effects. Clinical manifestations may be subtle and neurological abnormalities can occur without anemia or macrocytosis. Serum cobalamin alone is not always sufficient for diagnosis, and additional biomarkers may be useful in selected patients. Other nutrients, including vitamin D, iron, folate, calcium, zinc and iodine, require equally contextual assessment. The response should not be indiscriminate laboratory screening or indiscriminate supplementation. It should combine nutritional screening with clinical assessment, dietary history, functional evaluation, oral-health assessment, review of medications and gastrointestinal factors, targeted biochemical investigation and individualized intervention. Food remains the foundation: dietary diversity, nutrient density, appropriate textures and social accessibility matter. Fortification, supplementation and oral nutritional support have a role when food alone is insufficient. For internal medicine, the objective is not simply to normalize laboratory values, but to preserve muscle function, cognition, mobility, independence and quality of life. In an ageing society, the clinical challenge is therefore to nourish ageing, rather than merely to feed older people.

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Introduction

The Paradox of Food Abundance

Food abundance has not eliminated nutritional vulnerability in later life. An older person may consume sufficient or excessive calories while receiving insufficient amounts of vitamins and trace elements. Energy requirements tend to fall with age, whereas requirements for many micronutrients are maintained. The amount of micronutrients delivered per unit of energy therefore becomes increasingly important.

A systematic review of community-dwelling adults aged 65 years or older identified potential inadequacies for several micronutrients across different populations, although dietary inadequacy should not automatically be equated with biochemical deficiency [1]. The distinction is clinically important: dietary assessment describes exposure, biological measurements describe status, and symptoms and functional consequences describe clinical expression.

The European Society for Clinical Nutrition and Metabolism recognizes malnutrition and dehydration as widespread problems in older people and recommends systematic attention to nutritional risk, individualized assessment and multidisciplinary management [2]. Importantly, overweight and obesity do not exclude nutritional vulnerability. The contemporary older patient may therefore present with excess adiposity, low muscle mass and micronutrient inadequacy at the same time.

The clinical question should consequently shift from “Does this patient eat enough?” to “Does this patient receive enough essential nutrients, in a form that can be consumed, absorbed and used, to maintain function?” This change has major implications for clinical practice.

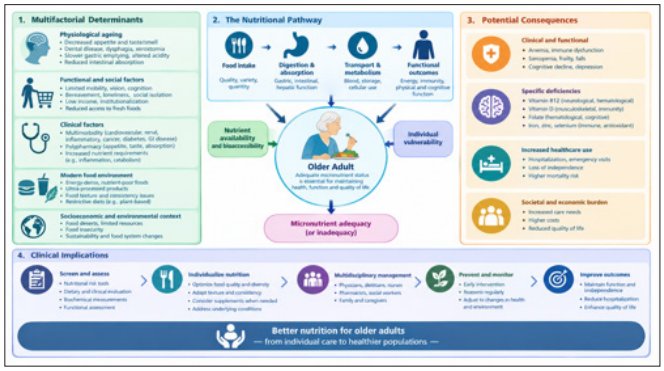

Figure 1: Determinants, Pathways, and Consequences of Micronutrient Vulnerability in Older Adults.

Legend of the Figure 1. Determinants, pathways, and consequences of micronutrient vulnerability in older adults. Micronutrient inadequacy in older adults results from the interaction of biological aging, functional and social limitations, clinical conditions, medication exposure, dietary patterns, and socioeconomic and environmental factors. These determinants can affect food intake, digestion and absorption, nutrient transport and metabolism, and ultimately tissue availability and biological function. The resulting deficiencies may contribute to hematologic, neurologic, musculoskeletal, immune, cognitive, and functional disturbances and may increase health-care utilization and loss of independence. A multidimensional approach combining nutritional screening, clinical and biochemical assessment, individualized nutritional intervention, multidisciplinary management, and longitudinal monitoring is therefore required. The figure emphasizes the continuum from determinants and mechanisms to clinical consequences and opportunities for prevention.

Why Ageing Changes Nutritional Vulnerability

Ageing modifies almost every stage of the nutritional pathway. Appetite commonly decreases, while changes in taste and smell can reduce interest in food. Dental disease, poorly fitting dentures, xerostomia and dysphagia may progressively restrict food choices. Fatigue, impaired mobility, visual impairment and cognitive decline can make shopping and meal preparation difficult. Bereavement, loneliness and social isolation can transform eating from a social activity into an irregular or solitary task.

Socioeconomic circumstances also matter. Limited income, dependence on others, institutionalization and reduced access to shops may favor inexpensive foods with high energy density but limited micronutrient diversity. Conversely, highly restrictive diets adopted for perceived health reasons may unintentionally eliminate important nutrient sources.

Ageing also changes gastrointestinal physiology. Gastric atrophy, altered acid secretion, impaired release of nutrients from food and gastrointestinal diseases can affect nutrient bioavailability. Vitamin B12 (cobalamin) is a particularly informative example because absorption depends on a complex sequence involving gastric processing, intrinsic factor and ileal uptake. Thus, apparently adequate dietary intake does not necessarily guarantee adequate biological availability.

Multimorbidity adds further complexity. Heart failure, chronic kidney disease, inflammatory disorders, malignancy, diabetes and gastrointestinal disease can modify nutritional requirements, appetite, metabolism and laboratory interpretation. Polypharmacy may influence appetite, taste, gastrointestinal function or nutrient absorption. Nutritional history should therefore be considered part of the medication history rather than an independent exercise.

The Contemporary Food Environment: Calories without Micronutrient Density

The modern food system offers unprecedented availability, convenience and variety, but these characteristics do not guarantee micronutrient adequacy. Processing itself should not be regarded as synonymous with nutritional harm. Pasteurization, freezing, drying, fermentation and fortification can improve safety, preservation, accessibility and, in some circumstances, nutrient availability. Concern arises when energy-dense products with limited micronutrient density displace foods that would otherwise provide protein, fiber, vitamins and trace elements.

For older adults, the relevant question is often not whether a particular food is “processed”, but what it replaces. A snack replacing fruit, a dairy product or a protein-containing meal may reduce dietary diversity; a fortified food replacing a less nutrient-dense product may do the opposite. Food texture is equally important. For a person with dysphagia or poor dentition, a nutritionally balanced soft meal may be preferable to an ideal food that cannot be eaten.

The broader food-system perspective is also relevant to diets that reduce animal-source foods. Plant-rich dietary patterns can provide substantial health benefits, but their micronutrient adequacy depends on food selection, preparation, fortification and, where appropriate, supplementation. Modelling of the EAT–Lancet planetary health diet identified potential shortfalls for several micronutrients, including vitamin B12, calcium, iron and zinc, illustrating that sustainability and nutritional adequacy must be considered together rather than separately [3-9].

Vitamin B12: A Model Micronutrient for the Ageing Population

Vitamin B12 illustrates why micronutrient medicine in older adults cannot be reduced to a dietary checklist. Andrès and colleagues highlighted the frequency of cobalamin deficiency in older patients and emphasized food-cobalamin malabsorption as an important mechanism [3]. Older adults may therefore have adequate apparent food intake while absorbing insufficient amounts of cobalamin.

The causes are heterogeneous. Reduced intake can occur with poor appetite, social isolation or diets that contain few animal-source foods or fortified alternatives. Malabsorption may result from gastric atrophy, pernicious anemia or gastrointestinal disease. Some long-term medications can also be associated with lower vitamin B12 status. The appropriate clinical response is to identify the mechanism rather than simply prescribe a supplement.

The manifestations of vitamin B12 deficiency are heterogeneous. Anemia and macrocytosis are classical findings but are not obligatory. Neurological and psychiatric manifestations may include peripheral neuropathy, gait disturbance, impaired balance and cognitive or neuropsychiatric symptoms. These symptoms overlap with common geriatric syndromes, making attribution difficult [3-5].

Serum vitamin B12 is widely available but has limitations. In selected patients, methylmalonic acid and homocysteine can provide additional evidence of functional deficiency, although renal dysfunction and other conditions can complicate interpretation [4-6]. In this situation, determination of the serum holotranscobalamin (active fraction of the vitamin B12) level may be of interest to establish the reality of the deficiency. The objective should be a coherent diagnosis based on symptoms, dietary exposure, absorption mechanisms and laboratory findings rather than reliance on a single threshold.

The Care B12 Group (Groupe d’étude des CAREnces en vitamin B12, Hôpitaux Universitaires de Strasbourg, France) experience illustrates a broader principle: cobalamin deficiency can serve as an entry point into comprehensive assessment of micronutrient vulnerability. When vitamin B12 is low or borderline, clinicians should ask why, whether other nutritional deficiencies are plausible, and whether the underlying problem is dietary, gastrointestinal, pharmacological, social or multifactorial.

Beyond Vitamin B12: A Multi-Dimensional Micronutrient Problem

Vitamin B12 should not become a diagnostic tunnel. Older adults may be vulnerable to inadequate vitamin D, folate (vitamin B9), iron, calcium, zinc, iodine and other micronutrients, with risk determined by diet, sunlight exposure, comorbidity, medication, absorption and living conditions [1,2]. Dietary inadequacy should be distinguished from established biological deficiency.

Vitamin D is influenced by dietary intake, sunlight exposure, season, latitude, obesity and chronic disease. Iron deficiency requires particular attention because it may reflect inadequate intake but can also signal chronic blood loss or gastrointestinal pathology. Folate status may be affected by dietary diversity and alcohol exposure. Calcium intake is closely linked to dairy or fortified alternatives and overall dietary pattern.

A major practical distinction is therefore required between population-level nutritional risk and individual biological deficiency. Laboratory investigation should answer a clinical question rather than become an indiscriminate micronutrient panel for every older person.

Frailty, Sarcopenia and Functional Independence

Micronutrient adequacy cannot be separated from the broader syndrome of nutritional and functional vulnerability. Malnutrition is associated with adverse clinical outcomes, while frailty and chronic disease can themselves reduce food intake and increase nutritional requirements. The relationship is bidirectional.

The Global Leadership Initiative on Malnutrition (GLIM) framework provides a clinically useful model in which nutritional risk screening is followed by diagnostic assessment and severity grading [7]. In older adults, this approach is more informative than body weight alone. Unintentional weight loss, reduced muscle mass, reduced food intake and disease burden can coexist with obesity.

Sarcopenia provides another bridge between nutrition and function. The European Working Group on Sarcopenia in Older People (EWGSOP) 2 consensus places low muscle strength at the center of the clinical definition, with muscle quantity or quality used for confirmation and physical performance informing severity [8]. Nutritional care should therefore be linked to resistance exercise, physical activity and rehabilitation whenever appropriate.

The meaningful endpoint is functional independence. A small improvement in a laboratory value has limited relevance if the patient remains unable to stand, walk, shop, prepare food or participate in social life. Preserving strength, mobility and autonomy may be a more meaningful marker of nutritional success than any isolated biochemical result.

Food, Medicines and Multimorbidity

Medication review should be integrated into nutritional assessment. Long-term acid suppression (e.g., proton-pump inhibitors), metformin and other treatments may be relevant in selected patients with vitamin B12 deficiency, while other drugs can influence appetite, gastrointestinal function or nutrient balance (e.g., GLP-1 receptor agonists). Such associations should prompt appropriate monitoring rather than automatic discontinuation of clinically indicated therapy.

Dietary restrictions deserve the same degree of scrutiny. Older adults may simultaneously receive recommendations for diabetes, renal disease, heart failure, dyslipidemia, hypertension, anticoagulation or food intolerance. The cumulative effect can be a diet so restrictive that its diversity becomes inadequate. Nutritional prescriptions should therefore be reconciled rather than simply added together.

Internal medicine, geriatrics and general medicine is particularly well positioned for this task because the problem is multidimensional. The physician must connect symptoms, diseases, medications, laboratory findings, functional status and social circumstances. Dietitians can translate this assessment into feasible meals and substitutions; nurses and other professionals can identify practical barriers; pharmacists can contribute to medication review; and swallowing specialists can address dysphagia.

From Nutritional Screening to Precision Nutritional Medicine

A pragmatic clinical pathway begins with screening but does not end there. Weight trajectory, appetite, food intake, functional decline and recent illness should be assessed routinely in vulnerable older adults. If risk is identified, a fuller nutritional assessment should include dietary diversity, oral health, chewing and swallowing, gastrointestinal symptoms, medication exposure, living arrangements and access to food.

Biological assessment should answer a clinical question. A patient with fatigue, neuropathy, macrocytosis, malabsorption or a restrictive diet may require targeted testing for vitamin B12 and folate; a patient with anemia may require iron studies and investigation of the underlying cause; a patient with bone fragility may require assessment of calcium and vitamin D status according to clinical context. Results should be interpreted in relation to inflammation, renal function, liver disease and other confounders.

Interventions should be proportional to the mechanism. They may include improving meal quality, increasing dietary diversity, changing texture, treating dental or swallowing problems, providing meal support, using fortified foods, prescribing oral nutritional supplements or administering targeted micronutrient replacement. Enteral or parenteral nutrition remains appropriate in selected patients when oral intake cannot meet requirements.

Supplementation should complement food, not substitute for understanding why food intake or nutrient utilization has failed. Conversely, food alone should not be insisted upon when a biological deficiency requires effective replacement.

A Food-system Perspective for an Ageing Society

Micronutrient deficiency in later life is not only a clinical problem. It is also shaped by food prices, agricultural production, fortification policies, food formulation, institutional catering and social inequalities. Hospitals and long-term-care facilities can influence nutritional status through menu design, meal timing, food texture, assistance with feeding and the social environment in which meals are consumed.

The EAT–Lancet Commission emphasized the need to reconcile human health with environmental sustainability [10]. For older adults, this framework requires additional attention to nutrient density, protein adequacy, bioavailability and individual clinical needs. Sustainable dietary patterns should not inadvertently create micronutrient deficits in vulnerable groups. Conversely, nutrient adequacy should not be pursued without considering affordability, cultural acceptability and environmental consequences.

Fortification can be particularly valuable when a nutrient is difficult to obtain consistently from food. Vitamin B12 is a notable example in populations consuming little or no animal-source food. Public-health strategies should make nutrient-dense choices accessible rather than relying exclusively on individual behavior change.

A Agenda for Clinical Practice

Internal medicine, geriatrics and general medicine should treat nutrition as a longitudinal component of chronic disease management. Nutritional status should be considered at hospital admission, after major changes in health status, during prolonged treatment and whenever functional decline occurs. A short dietary history can reveal major problems, but it should be connected to the patient's ability to shop, cook, chew, swallow and eat socially.

A practical consultation can integrate six domains: food intake and dietary diversity; weight and body-composition trajectory; gastrointestinal and oral factors; medication exposure; physical function and muscle health; and social access to food. Laboratory testing should then be selected according to the probability generated by these domains.

The Care B12 Group provides a useful model for collaborative research because cobalamin deficiency sits at the intersection of internal medicine, nutrition, gastroenterology, Haematology, laboratory medicine and geriatric care [3]. Future work should move beyond prevalence estimates toward clinically meaningful outcomes, including falls, mobility, cognition, sarcopenia, hospitalization, quality of life and independence. Digital dietary assessment and artificial intelligence may help identify trajectories of nutritional risk, but they should augment rather than replace clinical judgement and patient preferences.

Conclusion

Nourishing Ageing, not Merely Feeding it

The central paradox of modern nutrition in later life is that food abundance can coexist with micronutrient inadequacy. Older adults require an approach that recognizes declining energy expenditure, heterogeneous absorption, multimorbidity, polypharmacy, functional decline and social determinants of eating. Vitamin B12 provides a clear example, but the principle extends across the micronutrient spectrum.

The appropriate response is neither indiscriminate testing nor indiscriminate supplementation. It is a structured, individualized process that combines dietary quality and diversity with clinical assessment, targeted biomarkers, treatment of underlying causes and appropriate fortification or supplementation. Food remains the foundation, but food must be accessible, acceptable, chewable, swallowable, culturally appropriate and nutritionally dense.

For clinicians caring for older adults, the ultimate objective is not simply adequate calorie intake or a normal laboratory result. It is the preservation of strength, cognition, mobility, autonomy and quality of life. In an ageing society, we should therefore aim not merely to feed older populations, but to nourish ageing itself.

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Contributions

E.A., T.V and N.L.V. contribute in egal part to the production of the present text.

Use of Artificial Intelligence Tools

Artificial intelligence (AI)-based tools were used to assist with literature-oriented drafting, language editing, organization of the manuscript and identification of potentially relevant bibliographic sources. The authors retained full responsibility for the scientific content, interpretation of the literature, selection and verification of references, clinical statements, and final wording. AI-generated content was reviewed and revised by the authors. No AI tool is considered an author or responsible for the manuscript.

Conflict of Interest

The authors declare no conflict of interest with the contain of the present manuscript.

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