

Medical Nutrition
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Supporting optimal immune function in the elderly

The importance
of nutritional care



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Executive summary

Protecting peoples' immune health has never been more relevant. It is especially important to support immunity in older individuals—a vulnerable population group that does not respond to immune challenges, like infection and disease, or vaccinations as robustly as younger generations

Good nutrition is essential for optimal immune health. Considerable research exploring this area is driving new innovations and developments in the nutrition and medical communities, especially in the specialized nutrition market, where products targeted towards immune health can help to support older individuals in staying healthier for longer. Following the emergence of the SARS-Cov-2 infection, new expert advice has been issued by the European Society for Clinical Nutrition and Metabolism (ESPEN) to help safeguard patients and those at increased risk of complications from the disease, including older adults. The document outlines 10 practical recommendations for nutritional management before and during infection with SARS-Cov-2, including identification of individuals at risk of malnutrition, and details on how nutritional management can provide support.¹

Nutrition is well-recognized to play an important role in immune health and there is extensive and growing data demonstrating how different nutrients support immunity in older people. This whitepaper explores the role that nutrition plays in maintaining a well-functioning immune system despite advancing age, and how manufacturers can turn the latest nutritional science into targeted specialized nutrition solutions that will help support the health and independence of senior adults. Such specialized nutrition solutions should only be prescribed under supervision by a medical professional. The paper does not include recommendations for the use of pharmacological doses of nutrients for the treatment of specific diseases





Introduction to the immune system

An effective, fully functioning immune system – the body’s natural defense system – is essential in protecting people against pathogenic organisms, like bacteria, viruses, fungi and parasites; safeguarding the body from disease and infection and helping to maintain health throughout life.

However, the efficacy of the immune system declines with age – a phenomenon known as immunosenescence. This impacts health and recovery, which can lead to longer hospital stays and increased healthcare costs, as well as reduced quality of life and increased risk of death.²

An overview of the immune function

The immune system is permanently active and continuously carrying out surveillance for pathogens in the body. Upon detecting infection, its activity is amplified across two lines of defense: the innate immune system and adaptive immune system (figure 1). These systems have distinct, but inter-related mechanisms of action.

1. Innate immunity (fast, non-specific)

As the body’s first line of defense, the innate immune system provides an immediate, non-specific response to environmental stressors and pathogens.³ It consists of physical barriers that prevent pathogen entry (like the skin and gut epithelium) and a variety of phagocytic cells, cytokines and proteins (the complement system) that quickly recognize and remove ‘non-self’ threats. The response is typically inflammatory, but once the pathogen has been destroyed the immune system begins to resolve the inflammation and repair the damage caused by these processes.⁴ At the same time, its response to pathogens stimulates the activation of the adaptive immune response.

2. Adaptive immunity (slow, antigen-specific)

Also referred to as the acquired immune system, the adaptive immune system is comprised of specialized cells, namely T and B lymphocytes. T lymphocytes identify infected host cells before killing them directly or generating signaling molecules (called cytokines) that activate macrophages or B cells which subsequently destroy the infected cells. Meanwhile, B lymphocytes recognize antigens and secrete antibodies, enabling the phagocytosis and degradation of the pathogens. In these responses, both the T and B lymphocytes generate an immunological memory so that a faster adaptive response is triggered if the host is infected by the same pathogen in the future.⁴



Immunity in the elderly

Decline in immune function as we age is evidenced by the increased vulnerability of individuals aged 70 years and older to infections like influenza, and poorer responses to vaccinations.^{5,6,7} This is most obvious in long-term care facilities for the elderly, where there is a higher frequency, spread and severity of many infections.⁸

As well as immunosenescence, inflammaging is common in older people.² This describes the chronic low-grade inflammation, and resulting tissue damage, that develops with advancing age, and is thought to accelerate biological aging and contribute to many age-related diseases. Similarly, the inflammation induced by non-communicable diseases (NCDs) may also speed up biological aging, affecting immune health and function.

The impact of immunosenescence

Aging impacts both the innate and adaptive immune systems.⁹ Immunosenescence happens because of various factors, including cell senescence (irreversible arrest of cell growth), mitochondrial dysfunction and oxidative stress.^{10,11,12}

Immunosenescence affects the barrier function of the skin, mucus and gut epithelium, resulting in the immune system becoming weaker and less effective at preventing pathogens from entering the body.¹³

Activation of the immune system also appears to be compromised in old age, but even when it does respond it is less efficient.⁹ This is because immunosenescence impacts various immune cells – like T lymphocytes and macrophages – so that they do not function as well, or work slower to fight infection. Despite the accumulation of a broad range of memory cells over a lifetime, older people have slower and less effective memory-based immune responses to previously encountered pathogens.

The impact of inflammaging

The balance between the different components in the innate immune system is also affected by aging, resulting in an exaggerated inflammatory response and impaired resolution of inflammation, referred to as inflammaging.¹⁴ Inflammation is an important component of the immune response, but continued inflammation can result in damage to tissues and organs. As many NCDs, such as cardiovascular disease, cancer, sarcopenia and Alzheimer's disease are associated with underlying chronic inflammation, inflammaging can be further aggravated by the multiple morbidities often present in older people.¹⁵



Nutritional care to counter immunosenescence

Optimal nutrition is required for all cells to function properly, including immune cells. It supports their function by enabling them to initiate effective responses against pathogens.^{16,17,18} It also helps to resolve the inflammatory response adequately, protecting cells and tissues against unnecessary damage.

A number of nutrients play important roles in normal immune function. For example, vitamin E is required in various parts of the immune system – from phagocytosis to T cell proliferation and differentiation, antibody production and modulation of the inflammatory pathways.^{19,20} Meanwhile, micronutrients vitamin A and zinc help to regulate cell division, and are therefore essential for the successful proliferation of immune cells.¹⁶

Table 1 indicates the nutrient levels recommended for optimal support of immunity in the elderly population. Those who are poorly nourished are at a greater risk of bacterial, viral and other infections.^{21,22,3}

Nutrients support the immune system in several ways

1. Work as antioxidants to protect healthy cells and tissues
2. Support proliferation and activity of immune cells
3. Provide building blocks to produce antibodies and other proteins
4. Help to resolve inflammation

Table 1: Nutrient recommendations in the elderly for optimal immune health

Nutrient	Recommendation
Vitamins and trace elements	In addition to the consumption of a wellbalanced diet, a multivitamin and trace element complement is recommended to ensure individuals achieve optimal nutritional status ²³
Vitamin C	In healthy individuals: 200 mg/day In individuals who are sick: 1–2 g/day ²³
Vitamin D	50 µg/day (2000 IU/day) ²³ day ²³
Vitamin E	200 IU/day ²⁴
Zinc	In healthy individuals: 8–11 mg/day In individuals who have a low zinc status, 30 mg/day is advised, however, even higher levels may be needed in older adults ²⁵
Selenium	50–100 µg/day ²⁶
Omega-3 fatty acids (EPA and DHA)	500 mg/day EPA and DHA ^{27,28,29,30}

Ongoing immunonutrition research

EPA and DHA omega-3 fatty acids

Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) omega-3 fatty acids have important immune-regulatory functions.³¹ They help to optimize the immune system by enhancing the function of immune cells, whereas their anti-inflammatory and inflammation resolving properties contribute to an adequate inflammatory response.^{16,31} Following activation of the immune system, EPA and DHA help to resolve inflammation as part of the immune response by being converted into specialized pro-resolving mediators, such as resolvins, protectins and maresins.³² Together with other molecules, they coordinate the end of the inflammatory response and support healing.^{23,33,34}

One review concluded that slowing, controlling or reversing low grade inflammation is likely to be important in the prevention, or reduction in the severity of, age-related functional decline and the onset of diseases.²³ It found that dietary interventions with EPA and DHA may help to modify the low grade inflammation associated with aging, and therefore support the health of individuals as they grow older.

Vitamins

Vitamin C plays a key role in the innate and adaptive immune responses, helps to protect the body against excessive inflammation following an immune reaction and acts as a powerful antioxidant, helping to safeguard the body against oxidative stress.^{17,35} It is shown that regular intake of vitamin C supplements reduced the duration and severity of the common cold, for instance.³⁶

One study found that 200 mg/day vitamin C supplementation in hospitalized elderly people with severe acute respiratory infection had a beneficial effect on recovery, especially when baseline vitamin C status was low.³⁷ A more recent meta-analysis found that vitamin C supplementation reduced the risk of pneumonia, with the biggest effects seen in people with low dietary intakes.³⁸ In the same study, vitamin C also decreased the severity of pneumonia in older people, indicating that this nutrient is particularly important in the senior population. In light of this research, low intakes of vitamin C should be avoided as inadequate levels in the body can increase an individual's susceptibility to infections.¹⁷ Older individuals may need higher amounts of vitamin C than the general adult population, but this needs to be confirmed by additional research. Until then, at least 200 mg/day should be consumed.²³

Vitamin D also referred to as the 'sunshine vitamin' – contributes to a wide range of essential actions in the immune system. Because it promotes antimicrobial peptide synthesis in epithelial and immune cells, it is thought to help reduce a person's susceptibility to pathogens, including respiratory viruses.^{39,40} It also plays a role in suppressing excessive adaptive immune responses and helps mitigate the negative effects of inflammation.^{41,42} In older individuals, vitamin D deficiency is associated with general dysregulation of the immune system and increased levels of inflammation. A recent meta-analysis reported that daily or weekly vitamin D supplementation protected against acute respiratory tract infections in all individuals, including those that were older.⁴³ The benefits were greatest in patients with low vitamin D status.

Vitamin E has multiple benefits for the immune system – from phagocytosis to T cell proliferation and differentiation, antibody production and modulation of the inflammatory responses.^{19,20} One mechanism by which vitamin E is thought to exert its effects is by reducing oxidative damage in the membranes of immune cells.⁴⁴ Other benefits include enhanced T cell-mediated immune function in individuals with age-associated declines in their immune response, and improved wound healing.^{45,46}

In older people, vitamin E supplementation seems to enhance lymphocyte proliferation, antibody responses, natural killer cell activity and IL-2 secretion of activated naïve T cells.⁴⁷ Pre-clinical and clinical data strongly suggests that higher levels (200 IU/day) than currently recommended (22.5 IU/day) may be needed to achieve optimal immune function in the elderly.⁴⁸ In fact, a randomized controlled trial in 617 nursing home residents found that daily supplementation with 200 IU vitamin E over the course of one year reduced the risk of upper respiratory tract infection.⁴⁹ Another study reported increased resistance against pathogens in elderly populations when higher vitamin E supplementation was supplied.²⁴



Minerals

Zinc helps the innate and adaptive immune systems to respond properly by protecting immune cells against the effects of reactive oxygen species and by promoting their proliferation, maturation and activity.^{50,51,52,18} Zinc also has the ability to inhibit the entry of certain viruses into the host cell by stabilizing the cell membrane and preventing viral replication.^{53,54,55,56} Inadequate status of this essential nutrient is linked to reduced effectiveness of multiple immune cells.⁵⁷ Moreover, deficiency can lead to an imbalanced inflammatory response and increased oxidative stress, further contributing to the negative effects of inflammaging.⁵⁸ In older individuals, zinc supplementation has reduced the risk of infection and is associated with the enhancement of T cell function.^{44,25}

Iron supports immune function as it is an essential mineral for both the innate and adaptive immune responses, and low iron status is associated with a suboptimal immune response. However, the role of iron in immune defense is complex as it is required by the host immune system as well as by pathogens.⁶⁶ Iron is sequestered in macrophages and hepatocytes and intestinal absorption is reduced when infection occurs to limit its availability to the circulating pathogen.⁶⁷ Optimal iron levels for resisting infection therefore represent a balance between starving the pathogen of iron and compromising cellular immune competence.⁶⁸ Thus, although iron is identified as an important immune nutrient, complementary iron is not recommended in the absence of deficiency.

Selenium is a potent antioxidant that strongly influences inflammation and immune responses.⁵⁹ Via incorporation into selenoproteins, it is involved in regulating oxidative stress, redox reactions and other crucial cellular processes in nearly all tissues and cell types, including those involved in the innate and adaptive immune responses.^{60,61} Although limited clinical evidence is available, and results have been inconsistent, mounting research shows some benefits of selenium supplementation in individuals with inadequate selenium status. A review of preclinical studies found that selenium supplementation enhanced both cell-mediated and humoral immune responses.⁶² One study found that three days of intervention with selenium-enriched broccoli (200 µg/day) led to increased activation of peripheral blood mononuclear cells in healthy adults.⁶³ A second trial showed that supplementation with 50 µg/day or 100 µg/day selenium resulted in improved cellular immune markers and vaccine responses against poliovirus,⁶⁴ while a similar study had more mixed results concerning a range of immune parameters.⁶⁵



Achieving optimal nutritional care in the elderly:

Key considerations

Inadequate nutritional status and/or deficiencies in specific micronutrients are widespread among the senior population, even in affluent societies, and are often overlooked.⁶⁹

Malnutrition is estimated to affect between 15–30% of older people worldwide, however, these figures are higher in care homes, with up to 60% of elderly at risk of malnutrition in residential nursing homes.⁷⁰ Zinc deficiency is particularly prevalent in older adults living in care homes (30%), compared to those living in the community (5%).⁷¹ Inadequate or deficient vitamin D levels are also common in older persons, and are thought to be the result of factors such as reduced exposure to sunlight, being overweight or obese, low appetite and food intake, and impaired vitamin D absorption in the gut.^{72,73,74}

Understanding the reasons for malnutrition in elderly

There are numerous factors that contribute to malnutrition in the elderly. Known as 'anorexia of aging', the common loss of appetite and/or decreased food intake associated with advanced aging is complex and multifactorial. 'Anorexia of aging' involves physiological issues, like changes in the digestive system, hormonal fluctuations, disease, pain, and changes in sense of smell, taste and vision. It is also influenced by psychological and social factors too, which can strongly affect appetite.⁷⁵ Because of this, elderly people are less likely to consume or absorb the levels of nutrients required to maintain optimal immune functions, contributing to further deterioration of an already

weakened immune system. Moreover, commonly used medications for chronic conditions can alter nutrient requirements by interacting in ways that affect absorption or metabolism, while reduced energy expenditure can decrease appetite, making it even more difficult to achieve adequate nutrient intake.⁷⁵ These changes in appetite and food intake in the senior population – and subsequent nutrient deficiency – can lead to prevalent and overlapping conditions, like frailty (a loss of in-built reserves that affects a person's ability to cope with acute stressors) and sarcopenia (progressive and generalized loss of skeletal muscle mass, strength and function). These conditions can further attenuate immune function and increase an individual's risk and susceptibility to infection.⁷⁶ Nutritional management as part of elderly care may therefore help to address nutritional deficiencies in older individuals and support immune health.

Seniors are especially susceptible to malnutrition because they:

1. Have decreased energy requirements than younger adults, but similar or even higher requirements for essential nutrients
2. Experience decreased absorption for some nutrients
3. Often take medications which may interfere with the metabolism of certain micronutrients

The steps to supporting the elderly effectively

Getting the right nutritional care helps to support healthy immune function, reduce medical complications and promote the recovery and independence of elderly individuals.⁷⁷ Moreover, the prevention of malnutrition, which contributes to poor immune health, adverse patient outcomes and the development of NCDs can also support better health during rehabilitation.

This requires a holistic approach, which combines nutritional interventions with physical activity and medical care. Exercise plays an important role, as it helps to increase appetite, while also supporting the maintenance of muscle mass and improving muscle function.

Firstly, regular nutritional screening is important to identify patients at risk for malnutrition. For those who are at risk or malnourished, an in-depth assessment to understand the severity of the deficit, underlying causes, specific requirements (due to dysphagia or dementia), concomitant medication and individual food preferences is crucial. Ideally, optimal intake of nutrients is achieved through the consumption of a balanced and diverse diet. Therefore, a food-first approach is always recommended. However, the nutritional needs of the elder

ly community are complex, and it is a challenge to achieve the required nutrient density with food alone. Moreover, the requirements for some nutrients, like vitamin D, cannot be met even when an individual is consuming a balanced diet. This is particularly true for older people whose UVlight induced vitamin D production is less efficient than in younger people.



The role of specialized nutrition

Specialized nutrition products – like oral nutritional supplements, enteral feeding (tube feeding) or parenteral nutrition – may be considered in patients at high risk of malnutrition or in individuals unable to meet daily requirements via normal foods. In a recent DSM-Firmenich survey, for instance, it was revealed that individuals in care homes do not always fulfill their nutritional needs, with reduced appetite being one of the biggest barriers.⁷⁸ This lack of compliance can cause a number of issues, such as increased risk of malnutrition and lower immune function. A food first approach is always supported. But if that is not possible, creating tasty, palatable specialized nutrition solutions that can be easily consumed by the target group is critical.

To make these specialized nutrition solutions as appealing as possible, it is important to explore product and packaging attributes, such as smaller dosages, product formats (other than liquid), texture, easy-to-open packaging, and ingredients that add flavor or offer flavors that are nostalgic and not too exotic. In addition, making solutions as 'foody' as possible or developing products that can be easily integrated into mealtimes (like a sauce) or as snacks is key. This would help to overcome issues such as filling up too quickly on oral nutritional supplements, and then not eating at normal mealtimes which would decrease quality of life further.

To continue innovating though, more in-depth patient insights and scientific research is essential in order to better understand the needs of the elderly and reasons for non-compliance with existing care plans.

Your preferred partner for specialized nutrition innovation

Creating evidence-based specialized nutrition solutions takes more than ingredients. It requires a partner that is inspired by patients to continuously innovate to meet their needs.

As a purpose-led company, dsm-firmenich is passionate about supporting the health, recovery and independence of patients and the elderly, as well as reducing the burden on global healthcare systems. For dsm-firmenich, quality care and optimal diet are integral to the welfare of individuals in clinical settings, as both factors have a real impact on patient dignity and overall wellbeing. dsm-firmenich takes a science-led and human-centric approach to innovation; to ensure the patient's needs and preferences are addressed in a way that will ultimately enhance their quality of life. When you partner with dsm-firmenich, you get access to the broadest offering in the industry, customized solutions and expert services at every stage of your product's development so that you can meet the ever evolving and complex nutritional needs of patients and the elderly.

The dsm-firmenich philosophy

dsm-firmenich advocates a food-first approach where possible. It also sees education as essential in empowering those directly involved in elderly care so that they can identify and manage malnutrition via the implementation of appropriate care plans. Taking a human-centric and science-led approach to innovation is important as it enables care givers to address individual needs and ensures preferences are implemented as an integral part of meals or new specialized nutrition products.

dsm-firmenich offers specialized nutrition solutions designed with the benefit of:



In-depth insights from patients and elderly



Science-led innovation capabilities



Unrivalled formulation and application knowledge



A global network and local support



Unrivalled ingredients portfolio

dsm-firmenich provides a complete portfolio of science-based and high-quality nutritional ingredients. From vitamin straights, including vitamins as active pharmaceutical ingredients for parenteral nutrition, to EPA and DHA omega-3 fatty acids from marine and algae sources, dsm-firmenich's ingredients can be used in a range of specialized nutrition formulations.

Customizable solutions

dsm-firmenich's global capabilities allow for the formulation of fully customizable blends of the desired functional macro- and micronutrients in one single, efficient and homogenous premix. dsm-firmenich makes specialized medical nutrition solutions available to customers globally with its 15 state-of-the-art facilities strategically placed around the world.

Expert services

dsm-firmenich is committed to adding value at every stage of development – from concept to consumption – through its broad range of expert services available across its global network. These services support the development of specialized nutrition solutions that successfully address the needs and format preferences of people who require medical nutrition.

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