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REVIEW ARTICLE

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Major considerations of immune strengthening and health longevity in the light of nutrology and lifestyle change: a systematic review

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Abstract

Introduction: In the scenario of nutritional impacts on quality of life, genetic, environmental, and lifestyle factors can determine the life expectancy of human beings. Nutrition is a key component that affects our health, and several studies show that nutrition also has the potential to increase life expectancy. **Objective:** A systematic review was developed to describe immune strengthening and healthy longevity in light of nutrology and lifestyle changes. **Methods:** The PRISMA Platform systematic review rules were followed. The research was carried out from March to April 2025 in the Scopus, Embase, PubMed, Science Direct, Scielo, and Google Scholar databases. The quality of the studies was based on the GRADE instrument and the risk of bias was analyzed according to the Cochrane instrument. **Results and Conclusion:** A total of 134 articles were found, and 36 articles were evaluated, and 09 were included in this systematic review. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 28 studies with a high risk of bias and 32 studies that did not meet GRADE. Most studies showed homogeneity in their results, with X^2=82.7%>50%. It was concluded that nutrients and natural substances from human physiology and biochemistry such as melatonin and coenzyme Q10 control the functions of the immune system. Many metabolic or chronic diseases have been implicated in poor diet and lifestyle. Improving diet quality is associated with reduced all-cause mortality, considering that multivitamin and multimineral supplements can improve life expectancy. Overall well-being is improved when sedentary but sufficiently physically active adults reduce the time spent sedentary and increase physical activity levels. The results of the pandemic indicate there have been a variety of lifestyle changes, physical inactivity, and psychological problems.

Keywords: Nutrology. Lifestyle. Longevity. Immunity.

Introduction

In the context of nutritional impacts on quality of life, certain healthy foods are associated with longer telomere lengths. Furthermore, a high intake of whole grains, vegetables, fruits, nuts, and also coffee is associated with a reduced risk of all-cause mortality, while a high intake of red meat especially processed meat is positively related to all-cause mortality **[2]**. Furthermore, Mediterranean and high-quality diets are associated with a reduced risk of all-cause mortality **[3]**.

In this sense, preventive measures can radically change individuals' daily habits, including lifestyle-related behaviors **[2,3]**. In this regard, for example, in the context of the COVID-19 pandemic, staying and working from home can affect diet, food choices, and access to food, and thus reduce the possibilities and limit the practice of physical activity **[4,5]**. Thus, sedentary lifestyle and obesity have been described as a global public health problem **[6-8]**.

Reduced physical activity and lower energy expenditure can negatively affect physical and mental health **[9,10]**. In addition, the pandemic situation is also associated with emotions such as fear, sadness, and anxiety, which have been shown to reduce sleep quality **[10-12]**. Thus, the WHO has developed guidelines to be adopted during home quarantine **[13]**.

Furthermore, sedentary behavior, anxiety, and boredom caused by home confinement can influence the motivation to eat, change lifestyle patterns, reduce diet quality, and promote excessive consumption of high-calorie foods **[14,15]**. A healthy diet based on plant-based foods (vegetables and fruits), healthy fats, and foods low in fat and protein **[12,16]**, along with adequate activity, is the key strategy to support the immune system and restrict seasonal and viral infections in the population **[17,18]**.

Despite this, there is limited evidence to assess the effect of lockdowns and restrictions related to the COVID-19 pandemic on changes in dietary lifestyle behaviors **[19,20]**. Thus, changes in dietary lifestyle behaviors may be different depending on sociodemographic factors, body weight, and changes in employment and family type during quarantine. In this context, dietary supplementation with coenzyme Q10 (ubiquinone), melatonin, doses of vitamin C, vitamin D, minerals, short-chain fatty acids and omega-3 fatty acids, protein and carbohydrate content, Mediterranean diet and highfiber diet may be beneficial in strengthening the immune response to combat SARS-CoV-2 infection and decrease inflammatory processes and worsening of comorbidities such as hypertension, diabetes, obesity, chronic lung diseases, heart, liver and kidney diseases, tumors, clinically apparent immunodeficiencies, immunodeficiencies such as early type I interferon secretory capacity and pregnancy. Possible complications include acute respiratory distress syndrome, shock, disseminated coagulopathy, acute kidney injury, embolism, and secondary bacterial pneumonia **[21]**.

The role of nutrition in mental health is becoming increasingly recognized. Nutrition can be obtained from nutritional supplements, such as polyunsaturated fatty acids (PUFAs), vitamins, minerals, antioxidants, amino acids, and pre/probiotic supplements **[22]**. A large number of meta-analyses have emerged examining nutritional supplements in the treatment of mental disorders. The strongest scientific evidence has been found for PUFAs (primarily eicosapentaenoic acid) as an adjunctive treatment for depression **[22]**.

More recent evidence has suggested that PUFAs may also be beneficial for attention-deficit/hyperactivity disorder. Furthermore, folate supplements have been extensively investigated as adjunctive treatments for depression and schizophrenia. There is also emerging evidence for N-acetylcysteine as a useful adjunctive treatment in mood disorders and schizophrenia. In this context, clinicians should be informed of nutritional supplements with established efficacy for certain conditions, such as eicosapentaenoic acid in depression **[22]**.

Nutritional knowledge may influence dietary choices and impact athletic performance. Valid and reliable measures are needed to assess the nutritional knowledge of athletes and coaches. However, the current status of nutritional knowledge in athletes and coaches is difficult to determine. Knowledge gaps also remain, with the need for supplementation and the role of protein likely to be poorly understood. Previous reports of nutrition knowledge need to be interpreted with caution. A new, universal, updated, and validated measure of general sports nutrition knowledge is needed to enable the assessment of nutritional knowledge **[23]**.

Previous studies have shown that physical exercise and mindfulness meditation can lead to improved physical and mental health in athletes **[24]**. However, it is unclear whether these two forms of training share the same underlying mechanisms. Thus, a study compared two groups of elderly individuals with 10 years of experience in mindfulness meditation (integrative body-mind training (IBM) or physical exercise (PE) to demonstrate their effects on the brain, physiology, and behavior. Healthy elderly individuals were randomly selected from a large community health project and the groups were compared on measures of quality of life, autonomic activity (heart rate, heart rate variability, skin conductance response, respiratory

amplitude/frequency), immune function (secretory immunoglobulin A, sIgA), stress hormone (cortisol), and brain imaging (resting-state functional connectivity, structural differences). Compared to PE, the IBM group was found to have significantly higher scores on quality of life. Parasympathetic activity indexed by skin conductance response and high-frequency heart rate variability also showed more favorable results in the IBM group. However, the PE group had a lower baseline heart rate and higher thoracic respiratory amplitude. The baseline sIgA level was significantly higher and cortisol concentration was lower in the TICM group. These findings suggest that the combination of physical and mental training can achieve better health and quality of life results for the general population **[24]**.

Given this, the present study aimed to develop a systematic review to describe the strengthening of the immune system and increased longevity in light of nutrology and lifestyle changes.

Methods

Study Design

This study followed the international systematic review model, following the PRISMA (preferred reporting items for systematic reviews and meta-analysis) rules. Available at: http://www.prisma-statement.org/?AspxAutoDetectCookieSupport=1. Accessed on: 04/11/2025. The AMSTAR-2 (Assessing the methodological quality of systematic reviews) methodological quality standards were also followed. Available at: https://amstar.ca/. Accessed on: 04/11/2025.

Search Strategy and Search Sources

The literature search process was carried out from March to April 2025 and developed based on Scopus, Embase, PubMed, Science Direct, Scielo, and Google Scholar, covering scientific articles from various periods to the present day. The following descriptors (DeCS/MeSH Terms) were used: *"Nutrology. Lifestyle. Longevity. Immunity"*, and the Boolean "and" was used between the MeSH terms and "or" between the historical findings.

Study Quality and Risk of Bias

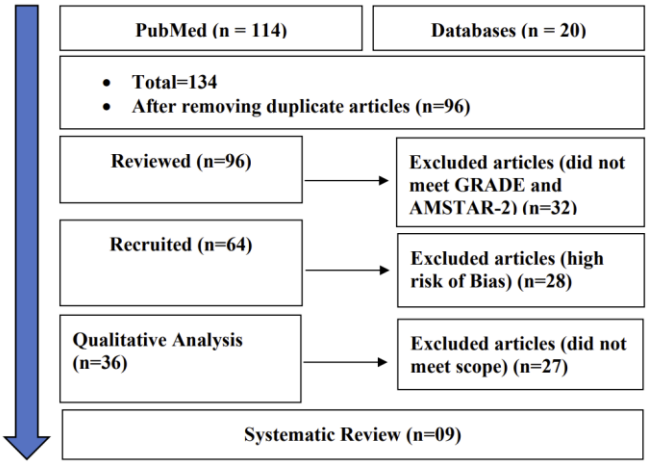
Quality was classified as high, moderate, low, or very low regarding the risk of bias, clarity of comparisons, precision, and consistency of analyses. The most evident emphasis was on systematic review articles or meta-analyses of randomized clinical trials, followed by randomized clinical trials. Low quality of evidence was attributed to case reports, editorials, and brief communications, according to the GRADE instrument. The risk of bias was analyzed according to the Cochrane instrument by analyzing the Funnel Plot graph (Sample size versus Effect size), using Cohen's test (d).

Results and Discussion

Summary of Findings

As a corollary of the literature search system, a total of 134 articles were found that were submitted to eligibility analysis and, subsequently, 09 of the 36 final studies were selected to compose the results of this systematic review. The listed studies presented medium to high quality (Figure 1), considering in the first instance the level of scientific evidence of studies in study types such as meta-analysis, consensus, randomized clinical, prospective, and observational. Biases did not compromise the scientific basis of the studies. According to the GRADE instrument, most studies presented homogeneity in their results, with X^2=82.7%>50%. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 28 studies with a high risk of bias and 32 studies that did not meet GRADE and AMSTAR-2.

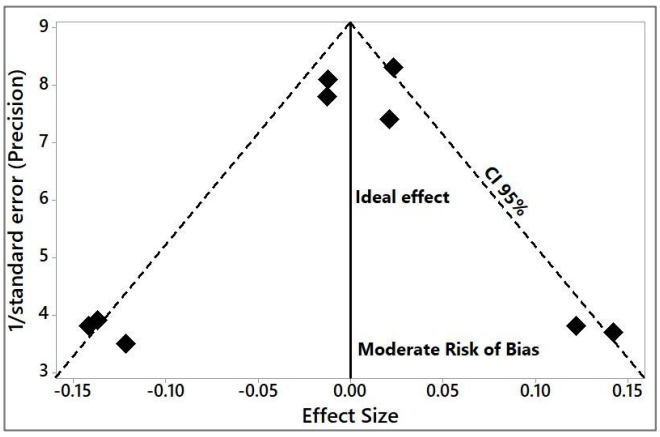
Figure 1. Process of recruiting articles for the systematic review.



Source: Own authorship.

Figure 2 presents the results of the risk of bias of the studies using the Funnel Plot, showing the calculation of the Effect Size (Magnitude of the difference) using Cohen's Test (d). Precision (sample size) was determined indirectly by the inverse of the standard error (1/Standard Error). This graph had a symmetrical behavior, not suggesting a significant risk of bias, both among studies with small sample sizes (lower precision) that are shown at the base of the graph and in studies with large sample sizes that are presented at the top.

Figure 2. The symmetrical funnel plot suggests no risk of bias among the studies with small sample sizes that are shown at the bottom of the graph. High confidence and high recommendation studies are shown above the graph (n=09 studies).



Source: Own authorship.

Immunity and Healthy Longevity in the Light of Nutrology and Lifestyle

In the context of nutritional imbalance and its relationship with body and mind, nutrients of interest for cognitive health include polyunsaturated omega-3 fatty acids, polyphenols, vitamin D, and B vitamins **[22]**. A review by the Scientific Advisory Committee on Nutrition (SACN) (2018) **[23]** suggested that the evidence is insufficient and inconclusive to support the idea that individual nutrients (vitamins C, E and B vitamins, omega-3s, polyphenols, flavonoids and caffeine) could prevent cognitive decline. Therefore, it remains to be demonstrated whether these individual nutrients are beneficial in preventing cognitive decline. It is difficult and harmful to assume that a single nutrient can cure all diseases. It is prudent to affirm the synergistic relationship of nutrients to influence physiological and cognitive function. For example, it is assumed that fish oils may be beneficial for brain health due to their omega-3 composition, but the evidence for fish oil and omega-3s does not indicate that they would be useful for preserving cognitive health **[24]**.

According to the literature, there is scientific evidence that foods/nutrients and natural substances of human physiology and biochemistry such as melatonin and coenzyme Q10 control the functions of the immune system, and many metabolic or chronic diseases have been implicated with poor diet and lifestyle **[25,26]**. In this sense, the large difference in mortality rates from COVID-19 between European countries suggests that diet and lifestyle may play a vital role in maintaining homeostasis essential to fight infection **[27]**.

Thus, the consumption of fermented vegetables has been shown to reduce the severity of COVID-19, that is, for each g/day of consumption of fermented vegetables the risk of mortality from COVID-19 was reduced by 35.4% **[28]**. Table 1 presents the main nutrients and organic substances and changes in dietary lifestyle responsible for immune control and reduction of viral load.

Table 1. Main nutrients and organic substances and changes in lifestyle **[23-30]**.

Nutrients	Functions
Coenzyme Q10	Coenzyme Q10 is an integral component of the mitochondrial respiratory chain and a key component of mitochondrial ATP production. The modulated mitochondrial dynamics and metabolism with lower CoQ10 levels in viral infections leads to the hypothesis that one of the main effects of the SARS-Cov-2 virus could be mitochondrial bioenergetic dysfunction with CoQ10 deficiency leading to reduced endogenous biosynthesis. The mechanism may be virus-induced oxidative stress.
Melatonin	Melatonin is known as an anti-inflammatory agent and immune modulator that may address the progressive pathophysiology of coronavirus disease 2019 (COVID-19). Thus, the use of melatonin may help reduce thrombosis, sepsis, and mortality. Furthermore, the combination of oral melatonin 3.0 mg tablets and standard treatment may substantially improve sleep quality and blood oxygen saturation in hospitalized patients. Clinical symptoms such as cough, dyspnea, and fatigue, as well as CRP levels and lung involvement in patients receiving melatonin, can be significantly improved with lifestyle changes.
Vitamin C	Vitamin C acts as an antioxidant and cofactor for regulatory enzymes and acts on both the innate and adaptive immune systems. Furthermore, vitamin C can attenuate pro-inflammatory action and pro-coagulant mechanisms, improving vascular and lung injury in sepsis. A recent randomized study evaluated patients with COVID-19 and suggested a beneficial effect of high-dose intravenous vitamin C on mortality.
Vitamin D	Vitamin D is well known to regulate gene transcription and immune response. The active metabolite of vitamin D, 1,25-dihydroxyvitamin D (1,25-(OH)2D3), modulates the activity of nuclear factor (NF)-κB and then induces the production of many molecules that amplify the inflammatory response, such as IL-6, IL-1β, TNF-α, and IFN-α, stimulates the production, mobilization, and adhesion of inflammatory cells, and influences the production of enzymes such as inducible nitric oxide synthase (iNOS), cyclooxygenase-2, and phospholipase A2. A study indicated that vitamin D improves the inflammatory response through multiple pathways protects against respiratory infections and reduces the risk of influenza and COVID-19.
Protein	There is still no clinical evidence on high-protein diets in COVID-19. In a preclinical study, rats with protein malnutrition had a decreased expression of IFN-α, TNF-α, and iNOS in lung tissues, understanding their ability to fight infection. Thus, adequate protein intake to maintain physiological needs is essential in maintaining a healthy immune response to protect against SARS-CoV-2.

Carbohydrates	There is still no clinical evidence on high-protein diets in COVID-19. A high-carbohydrate diet is known to contribute to the prevalence of obesity, insulin resistance, and type 2 diabetes, which are risk factors for COVID-19.
Mediterranean Diet	The Mediterranean diet is typically rich in vegetables, fruits, whole grains, beans, nuts, seeds, and olives. Weekly intake of fish, poultry, eggs, and dairy products should be moderate, but red meat intake should be limited. This diet may have protective effects against COVID-19, as shown by several studies on dietary lifestyle changes during the pandemic.
Ketogenic Diet	The ketogenic diet is a low-carbohydrate diet resulting in a metabolic state called ketosis. The ketogenic diet leads to weight loss, decreased blood sugar, and favorable changes in serum triglycerides. Furthermore, the ketogenic diet has been proposed as a prophylactic diet to reduce viral loads, as well as having anti-inflammatory action through modulation of immune metabolism and prevention of cytokine storm syndrome.
Minerals	For example, magnesium was inversely correlated with hs-CRP, IL-6, and TNF-α levels. Common trace elements such as zinc, iron, copper, and selenium also act as cofactors for several enzymes involved in antioxidant reactions and have strategic immunomodulatory roles. However, scientific evidence for these minerals in COVID-19 is still lacking.
Short-Chain Fatty Acids	Short-chain fatty acids are metabolic compounds fermented from dietary fiber by the gut microbiota. Increased short-chain fatty acids have been associated with higher whole grain intake and exert anti-inflammatory effects through G-protein-coupled receptor modulates cytokine secretion in monocytes.
Omega-3 fatty acids	Omega-3 polyunsaturated fatty acids (PUFAs), especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), have been shown to exhibit anti-inflammatory effects in several diseases. Lipid autacoids derived from arachidonic acid, including prostaglandins (PGs), thromboxane, and leukotrienes, are collectively termed eicosanoids and are critical mediators of inflammation, resolution, and tissue homeostasis. Infectious processes can activate the formation of inflammasomes leading to an eicosanoid storm consisting of both pro-inflammatory and anti-inflammatory mediators. SARS-CoV-2 infection leads to tissue damage, cellular debris release, endoplasmic reticulum stress, induction of inflammatory enzymes, and thus triggering an eicosanoid storm, which then stimulates a cytokine storm. Thus, PUFAs and omega-3s may ameliorate the inflammatory state caused by viral infections, including COVID-19.
High-fiber diet	A high-fiber diet has beneficial effects on glucose metabolism, leading to lower blood glucose and higher insulin-sensitizing adipocytokine levels. It can also reduce levels of pro-inflammatory cytokines such as IL-6, IL-18, and TNF-α.

Source: Own authorship.

A cross-sectional observational study among adults in the United Arab Emirates was conducted using an online questionnaire. A total of 1,012 subjects participated in the study. During the pandemic, 31% reported weight gain and 72.2% drank less than eight glasses of water per day. Furthermore, the participants' dietary habits deviated from the Mediterranean diet, with less healthy dietary lifestyles. Furthermore, 38.5% did not engage in physical activity and 36.2% spent more than five hours per day on screens for entertainment. Furthermore, the majority of participants reported physical exhaustion, emotional exhaustion, irritability, and tension during the pandemic compared to before the pandemic, and sleep disorders were prevalent in 60.8% of participants. Therefore, the results of the pandemic indicate that there were a variety of lifestyle changes, physical inactivity, and psychological problems among adults in the United Arab Emirates **[29]**.

Finally, another observational cross-sectional online survey study identified dietary change patterns during the COVID-19 pandemic and their associations with sociodemographic data, body mass index (BMI), and lifestyle changes in Polish adults. A total of 43% of respondents decreased physical activity, 49% increased screen time, and 34% increased food consumption. Among the three dietary change patterns, two opposite patterns were found, healthy (28% participants) and unhealthy (19% participants). Furthermore, participants residing in a macroeconomic region decreased adherence to healthy eating. Therefore, adults over 40 years old, with children, unemployed, and those living in a macroeconomic region were shown to be more exposed to unhealthy behaviors **[30]**.

Conclusion

It was concluded that nutrients and natural substances of human physiology and biochemistry such as melatonin and coenzyme Q10 control the functions of the immune system. Many metabolic or chronic diseases have been implicated in poor diet and lifestyle. Improving diet quality is associated with reduced all-cause mortality, whereas multivitamin and multimineral supplements may improve life expectancy. Overall Well-being is improved when sedentary but sufficiently physically active adults reduce sedentary time and increase physical activity levels. Results from the pandemic indicate a range of lifestyle changes, physical inactivity, and psychological problems.

CRediT

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