


# Dietary recommendations during the COVID-19 pandemic

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*Optimal nutrition can improve well-being and might mitigate the risk and morbidity associated with coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). This review summarizes nutritional guidelines to support dietary counseling provided by dietitians and health-related professionals. The majority of documents encouraged the consumption of fruits, vegetables, and whole grain foods. Thirty-one percent of the guidelines highlighted the importance of minerals and vitamins such as zinc and vitamins C, A, and D to maintain a well-functioning immune system. Dietary supplementation has not been linked to COVID-19 prevention. However, supplementation with vitamins C and D, as well as with zinc and selenium, was highlighted as potentially beneficial for individuals with, or at risk of, respiratory viral infections or for those in whom nutrient deficiency is detected. There was no convincing evidence that food or food packaging is associated with the transmission of COVID-19, but good hygiene practices for handling and preparing foods were recommended. No changes to breastfeeding recommendations have been made, even in women diagnosed with COVID-19.*

## INTRODUCTION

In January 2020, the world faced an outbreak of coronavirus disease 2019 (COVID-19), caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). Evidence of high human-to-human transmissibility of SARS-CoV-2 has made social isolation the best preventive measure to avoid the spread of COVID-19.<sup>1</sup> This pandemic is substantially affecting lifestyles, healthcare systems, and national and global economies. Social isolation is often an unpleasant experience that

may have negative effects on mental health.<sup>2</sup> It has been suggested that, until quarantine ends, self-isolation is likely to cause psychological and emotional symptoms,<sup>3</sup> changes in mood and altered sleep or eating patterns,<sup>4</sup> worsening of chronic health conditions, weight gain, and increased use of alcohol, tobacco, or illegal drugs.

Optimal nutrition is one of the main determinants of health that can improve well-being and mitigate the harmful health consequences associated with social distancing by helping to prevent or control most chronic diseases (eg, diabetes, hypertension, and excess body

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weight/obesity); aid in the regulation of sleep and mood; and prevent fatigue.<sup>5,6</sup> Nutritional modulation of the immune system is also important across the age spectrum. During early childhood, breastfeeding can provide protection against infections and respiratory diseases, as breast milk contains antibodies, enzymes, and hormones that can offer health benefits.<sup>7</sup> In older adults, the group at most risk for COVID-19, changes in dietary habits lead to significant alterations in immunity and inflammation, termed *immunosenescence* and *inflammaging*.<sup>8</sup> Some nutrients, such as omega-3 polyunsaturated fatty acids and probiotics, have been linked to anti-inflammatory responses and enhanced resistance to upper respiratory tract infection.<sup>8</sup>

In individuals infected with SARS-CoV-2, nutritional status is a crucial factor for optimal prognosis and can determine the clinical severity of COVID-19.<sup>9</sup> Dietary supplementation with selected vitamins (eg, A, B, C, and D), minerals (eg, selenium, zinc, and iron), and omega-3 fatty acids was suggested by Zhang and Liu<sup>10</sup> as a treatment option for COVID-19 patients and as preventive therapy against lung infection. However, the use of micronutrient supplements to prevent infections remains questionable.

Since to date there is no vaccine or evidence-based treatment for COVID-19, the optimization of nutrient intake through well-balanced meals and the use of good hygiene practices in food selection, preparation, and conservation is probably the most effective approach for managing the continuous risk of viral infection. To this end, dissemination of healthy eating guidelines for healthcare professionals and the general public is a crucial strategy. Despite intense efforts by international nutrition organizations and other health-related societies to produce guidelines and advice related to the COVID-19 pandemic, literature is still scarce. Meanwhile, the general public has been bombarded with a vast array of nutritional information from governmental authorities, the dietary supplement industry, nutrition enthusiasts, healthcare professionals, and others on how to prevent COVID-19. This information, however, may be conflicting or non-evidence based.

Therefore, a systematic search of guidelines and official documents related to nutrition and COVID-19 was conducted. The search included information obtained from several countries affected by the pandemic as well as manuscripts identified in scientific databases. The goal was to address one main question: What nutritional advice is being offered for individuals in quarantine during the COVID-19 pandemic? The aim of this review was to summarize nutritional guidance related to the novel coronavirus (SARS-CoV-2) in order to support dietary counseling provided by

dietitians and healthcare professionals during this pandemic.

## METHODS

This narrative review was carried out from December 2019 to April 2020, during the COVID-19 pandemic. Guidelines and official documents from governmental and nongovernmental health agencies or institutions worldwide, all providing recommendations on food and nutrition during the COVID-19 pandemic, were eligible for inclusion. Literature related to specific nutritional or pharmacological treatment of patients already infected was excluded.

The descriptors “coronavirus,” “COVID-19,” “COVID” AND “nutrition” OR “diet” were used to search for guidelines, position papers, and official documents in the PubMed, SciELO, Cochrane, and Google databases. The Boolean operators “AND” and “OR” were used to combine the terms used in the literature search. Publications in the following languages were searched: Italian, English, Spanish, and Portuguese. Two authors (J.F.M. and F.C.C.) conducted the search and screened all references independently in a 2-step process. All selected documents were retrieved, and duplicates were excluded. Titles and abstracts were then screened to identify studies that potentially met the eligibility criteria.

## RESULTS

Of the 48 documents retrieved, 13 were included in this narrative review. Of these, 8 dietary recommendations were issued from nutrition societies and associations and 6 from national governments (Australia, Brazil, Canada, Italy, Spain, United States). Five guidelines from health organizations (Food and Agriculture Organization of the United Nations, World Health Organization, United Nations Children’s Fund, Center for Disease Control and Prevention, and European Food Information Council) were included. A summary of the guidelines, main advice, and other information is provided in [Table 1](#).<sup>11–25</sup> Four major nutrition-related topics—overall dietary recommendations, dietary supplements, breastfeeding, and food hygiene—were identified.

### Dietary recommendations

Nearly 70% of the documents retrieved encouraged the consumption of fruits, vegetables, and whole grain foods. Two nutrition societies, from Italy and Spain,<sup>12,22</sup> recommended at least 5 servings of fruits and vegetables per day. Diets rich in fruits and vegetables contain high

**Table 1 Summary of dietary recommendations disseminated during the coronavirus disease 2019 (COVID-19) pandemic**

Institution	Dietary recommendations	Supplementation/breastfeeding recommendations	Food hygiene recommendations
ABRAN (2020) <sup>11</sup>	Most-relevant vitamins and minerals: vitamin A, vitamin C, vitamin D, zinc (vegetarians may need up to 50% more dietary zinc than nonvegetarians), selenium; Probiotics can be considered in COVID-19 patients who have diarrhea	Supplementation with vitamins, minerals, and probiotics does not treat or prevent COVID-19 infection, but it can optimize the immune response, acting as an adjunct treatment; For individuals at risk of respiratory viral infections, high doses of vitamin C (up to 2 g/d) orally can be indicated; In groups at risk or with low sun exposure, vitamin D between 2000 and 4000 IU/d orally may be indicated; Maximal zinc intake should not exceed 40 mg/d; Higher doses of selenium (200 µg) can act as adjunct therapy in the treatment of infections but cannot be used for an extended period of time	NA
AEDN & GCDN (2020) <sup>12</sup>	Maintain good hydration; Consume at least 5 servings of fruit and vegetables per day; Consume whole-grain products and legumes; Choose low-fat dairy products (milk and fermented milks or yogurt); Consume other foods of animal origin in moderation; Consume nuts, seeds, and olive oil; Avoid processed foods and fast food Prioritize fresh or minimally processed foods;	NA	NA
ASBRAN (2020) <sup>13</sup>	Use oils, fats, salt, and sugar in small amounts when preparing meals; Limit consumption and purchase of processed and ultraprocessed foods such as french fries, soft drinks, cookies, and ice cream, which are rich in empty calories; Use all parts of fruits and vegetables in recipes; Avoid buying commercially prepared meals that are rich in sodium, trans fat, and calories	NA	Before placing supplies in cupboards or pantries, wash the packaging with soap and water and spray with 70% alcohol or a chlorinated solution; Fruits and vegetables that are stored in the refrigerator should be removed from packaging and sanitized beforehand; Before consumption, raw fruits and vegetables should be washed under running water and sanitized with sodium hypochlorite, which should always be used diluted, as instructed on the packaging
ASN (2020) <sup>14</sup>	The healthiest meals emphasize whole grains, vegetables, and fruits; Meat portions should be smaller to limit intake of saturated fat; Limit consumption of commercially prepared frozen dinners; Stock up on nutrition-packed foods that will stay fresh for a week or longer	NA	When grocery shopping, use a disinfecting wipe to wipe hands and grocery cart handle
CDC (2020) <sup>15,16</sup>	NA	Although COVID-19 has not been detected in breast milk, it is not known whether mothers with COVID-19 can spread the virus during breastfeeding;	Washing hands with soap (20 seconds) before preparing or eating food is important for general food safety;

(continued)

Table 1 Continued

Institution	Dietary recommendations	Supplementation/breastfeeding recommendations	Food hygiene recommendations
		When breastfeeding, mothers with COVID-19 should wear a face mask and wash hands before each feeding	Keep raw meat separate from other foods; refrigerate perishable foods; and cook meat to the recommended temperature to kill harmful microorganisms
DAA (2020) <sup>17</sup>	When selecting fruits and vegetables, choose fresh options that last longer; other options are frozen, dried, and canned produce; Keep canned soup on hand; Recommended protein sources include canned fish, legumes (canned or dried), nuts, and seeds; Choose long-life milk (ultra-high temperature or powdered milk); Consider a range of grains, such as rice, pasta, quinoa, couscous, rolled oats, and other cereal grains; Use herbs and spices to reduce salt intake. Foods that are a source of comfort or a reminder of daily routine can be beneficial for mental health	NA	NA
Dietitians of Canada (2020) <sup>18</sup>	Consume a healthy diet rich in fruit and vegetables, protein foods, and whole grains; There is no single food, supplement, or natural health product that will prevent, treat, or cure COVID-19	Women who choose to breastfeed should be allowed to do so after appropriate handwashing and while wearing a mask	There is no evidence that COVID-19 is spread through eating or touching raw fruits or vegetables; Prior to consumption, fresh fruits and vegetables should be washed or scrubbed under cold, running, potable tap water; While there are no special precautions for storing food, handwashing after putting away purchased food and before preparing food is recommended; Hands should be washed before and after food containers are washed Wash hands for 20 seconds with soap before and after preparing or eating foods; Wash fruits and vegetables before eating; Disinfect surfaces and objects before and after use; Keep raw and cooked foods separate from each other; Use different utensils/chopping boards for raw and cooked foods; Cook and reheat foods to adequate temperatures ( $\geq 72^{\circ}\text{C}$ for 2 min); There is no need to disinfect food packaging items
EUFC (2020) <sup>19</sup>	Appropriate intakes of copper, folate, iron, selenium, zinc, and vitamins A, B <sub>6</sub> , B <sub>12</sub> , C, and D play an important role in the immune system; In general, these nutrients should be obtained through foods	Supplements can be used to add nutrients to the diet in individuals who have specific challenges in meeting dietary requirements	Continue to practice good food hygiene; There is no evidence that COVID-19 can be spread through contact with purchased foods; Store raw and cooked foods separately; keep food preparation surfaces clean; cook foods thoroughly; store food at safe temperatures; and use safe water and raw materials
FAO (2020) <sup>20</sup>	Consume a healthy diet to support a strong immune system; Eat a variety of foods within each food group; Eat plenty of fruits and vegetables; Consume a diet rich in whole grains, nuts, and healthy fats; Limit intakes of fat, sugar, and salt; Drink water regularly; Limit consumption of alcohol;	NA	

(continued)

Table 1 Continued

Institution	Dietary recommendations	Supplementation/breastfeeding recommendations	Food hygiene recommendations
SIN (2020) <sup>21</sup>	There are no foods or dietary supplements that can prevent COVID-19 infection NA	For mothers previously diagnosed with COVID-19 or under investigation for possible COVID-19, rooming-in with the infant is feasible, and direct breastfeeding is advisable, provided strict measures of infection control are in place; Fresh expressed breast milk (no need for pasteurization) is recommended when a mother with COVID-19 is too sick to care for her newborn	NA
SINU (2020) <sup>22</sup>	Consume 5 servings per day of fruit and vegetables as sources of vitamins A and C; Expose arms and legs to the sun every day for 15–30 minutes to promote endogenous synthesis of vitamin D; Avoid weight gain by reducing the consumption of sugary drinks and other sugar-rich products; Avoid excessive consumption of salt and seasonings rich in fat	NA	NA
UNICEF (2020) <sup>23</sup>	Maintain fruit and vegetable intake; Choose healthy dried or canned alternatives when fresh produce is not available; Canned oily fish is rich in protein, omega-3 fatty acids, and a range of vitamins and minerals; Build up a stock of healthy snacks; Limit highly processed foods; Make cooking and eating fun and meaningful	Breast milk remains an optimal food for infants and children aged 6 to 24 months; Women with COVID-19 can continue to breastfeed; If mother is too unwell to breastfeed due to COVID-19 infection or other complications, she should receive support to safely provide her newborn with breast milk in any way possible; Practice respiratory hygiene during feeding, wearing a mask when available; Wash hands before and after touching the baby; Routinely clean and disinfect surfaces	Any unnecessary packaging and refuse must be removed and placed into a waste bin with a lid; Packaging like cans can be wiped clean with a disinfectant before being opened or stored; Wash hands with soap and water for at least 20 seconds; or use an alcohol-based hand rub; Unpackaged produce, such as fruit and vegetables, should be washed thoroughly under running water
WHO (2020) <sup>24,25</sup>	Vitamins, minerals, dietary fiber, protein, and antioxidants can be obtained from a variety of fresh and unprocessed foods; Drink enough water; Avoid sugar, fat, and salt	Women with COVID-19 can breastfeed; Practice respiratory hygiene during feeding, wearing a mask when available; Wash hands before and after touching the baby; Routinely clean and disinfect frequently used surfaces	NA

*Abbreviations:* ABRAN, Associação Brasileira de Nutrologia (Brazilian Association of Clinical Nutrition); AEDN & GCDN, Academia Española de Nutrición y Dietética y el Consejo General de Colegios Oficiales de Dietistas-Nutricionistas (General Council of Official Colleges of Dietitians-Nutritionists); CDC, Centers for Disease Control and Prevention; DAA, Dietitians Association of Australia; EUFIC, European Food Information Council; FAO, Food and Agriculture Organization of the United Nations; SIN, Società Italiana de Neonatologia (Italian Society of Neonatology); SINU, Società Italiana di Nutrizione Umana (Italian Society of Human Nutrition); UNICEF, United Nations Children’s Fund; WHO, World Health Organization.

amounts of vitamins and minerals, including vitamins A, C, D, E, and B complex, as well as zinc and selenium, which are important modulators of the

immune system.<sup>26</sup> In addition, fruit and vegetables are good sources of water, antioxidants, and fiber, all of which play a role in the control of hypertension,

diabetes, and weight gain, some of the most important risk factors for COVID-19 complications.<sup>27</sup>

Micronutrients contribute to immune function through a variety of pathways in both innate and adaptive immune responses. Vitamins A, C, D, E, B<sub>6</sub>, and B<sub>12</sub> and zinc are important for the maintenance of structural and functional integrity of physical barriers (eg, skin, gastrointestinal lining, respiratory tract, and others) as well as for the differentiation, proliferation, function, and migration of innate immune cells.<sup>28</sup> Meanwhile, vitamins C and E, along with zinc and selenium, protect against free radical damage during increased oxidative stress. Vitamins A, C, D, E, B<sub>6</sub>, and B<sub>12</sub> and zinc and selenium support the adaptive immune response by influencing the differentiation, proliferation, and normal function of T and B cells. These nutrients also affect antibody production and function,<sup>28</sup> contribute to cell-mediated immunity, and support the recognition and destruction of pathogens. Lastly, they have antimicrobial activity and regulate the inflammatory response.<sup>28</sup>

Approximately one-third of the identified guidelines mentioned at least one of these nutrients as being important for optimizing the immune system, placing special emphasis on zinc and vitamins C, A, and D.<sup>11,19,22</sup> Adequate intakes of these micronutrients may be attained through a daily diet that includes meat, fish, lentils and beans, dairy foods, nuts, seeds, eggs, citrus fruits (eg, orange, lemon, grapefruit), kiwi, strawberries, and vegetables such as broccoli, cauliflower, pumpkin, spinach, sweet potato, and carrots. While vitamin D can be obtained from some dietary sources, it is mainly synthesized endogenously through exposure of the skin to ultraviolet B irradiation. In fact, sunlight exposure can increase serum vitamin D levels to the same extent as an oral dose of 250 to 625  $\mu\text{g}$  of vitamin D.<sup>29</sup> The Società Italiana di Nutrizione Umana<sup>22</sup> recommended exposure to sunlight for 15 to 30 minutes every day to promote the synthesis of vitamin D. However, in latitudes outside 40° north and south, ultraviolet B radiation is greatly reduced during winter. As a result, an increased intake of vitamin D–rich foods, as well as vitamin D supplementation, might be necessary to maintain adequate serum levels in winter.<sup>30,31</sup>

Almost, one-third of the organizations and societies recommended avoiding the intake of salt, fat, and sugar and encouraged reductions in sugary drinks, other sugar-rich products, meat portions, and other foods of animal origin to lower the intake of saturated fat.<sup>12–14</sup> In addition, they suggested that low-fat dairy foods and healthy fats (eg, olive oil and fish oil) be included in the diet<sup>12,23</sup> and recommended sauces, spices, and herbs as salt substitutes.<sup>17</sup>

Over the last 30 years, the literature has described a definitive role of fat in immunity. Saturated fatty acids act on Toll-like receptor 4, a sensor that binds bacterial lipopolysaccharide and thus acts in the innate immune response. As a result, a high intake of saturated fatty acids favors low-grade inflammation.<sup>32</sup> On the other hand, monounsaturated and polyunsaturated fatty acids are known for their favorable immune-modulatory action.<sup>33</sup> Omega-3 polyunsaturated fatty acids present in seafood, algal oil, marine fish, and flaxseed support the immune system by activating cells from both the innate and the adaptive immune systems,<sup>34</sup> while omega-9 monounsaturated fatty acids found in olive, sunflower, and safflower oils and nuts have antioxidant, antimicrobial, and antiviral effects.<sup>35</sup> For adult males and non-pregnant/nonlactating adult females, the recommended dosage of omega-3 polyunsaturated fatty acids (eicosapentaenoic acid plus docosahexaenoic acid) is 250 mg/d.<sup>36</sup> This recommendation can be met by consuming at least 2 portions (90 g each) of fatty marine fish, such as mackerel, salmon, sardine, herring, and smelt, per week.<sup>36</sup>

Drinking water or maintaining adequate hydration was suggested in 3 documents,<sup>12,20,24</sup> but no guidance on water requirements (eg, cups or milliliters per day) was provided. The evidence in favor of a direct association between hydration status and health has been previously confirmed. Water is essential for cellular homeostasis, kidney function, body temperature control, mood regulation, cognitive function, gastrointestinal and heart function, and headache prevention.<sup>37</sup>

It is important to note that diets low in water and rich in salt can negatively impact kidney function.<sup>38</sup> In addition, the consumption of sugary drinks instead of water increases the intake of carbohydrates and calories, thereby raising blood glucose and exacerbating obesity and other related chronic diseases. Because of their low water reserves, older adults can be affected more seriously by hypohydration.<sup>38</sup> Furthermore, water intake comes mostly from beverages (about 75%) and food intake (about 25%), especially from fresh food such as fruits and vegetables.<sup>38</sup> Therefore, advice on the importance of drinking water, tea, and milk and consuming other water-containing foods should be delivered by dietitians and healthcare professionals during the COVID-19 pandemic. Since the daily water requirement is influenced by age, sex, level of physical activity, diet, body composition, pregnancy, environmental conditions, and the presence of disease, the recommended intake of water varies widely and can reach 3.7 L/d for older adults (including all water contained in food, beverages, and drinking water).<sup>39</sup> According to the *Dietary Reference Intakes for Water, Potassium, Sodium,*



Chloride, and Sulfate,<sup>39</sup> adults with moderate levels of physical activity who consume approximately 2200 kcal/d can meet water recommendations by drinking 12 cups of water and beverages daily, while children require 4 to 5 cups per day, adolescents (9 to 18 years) 7 to 11 cups per day, and older adults 9 to 13 cups per day.

While some organizations recommend choosing unprocessed foods,<sup>12,13,22–24</sup> healthy dried, frozen, or canned foods (eg, fish, fruits, soups) are suggested as alternatives when fresh produce is not available.<sup>17,23</sup> There is a current trend for guidelines to support home-made and fresh meals instead of processed foods. Several countries, including, Brazil,<sup>40</sup> Chile,<sup>41</sup> Australia,<sup>42</sup> and Canada,<sup>43</sup> have recommended limiting the intake of processed foods, which are linked to cancer, obesity, hypertension, and diabetes.<sup>44</sup> Interestingly, there has been a worldwide trend for individuals to stock up on processed foods during the quarantine. This has been recommended by governmental agencies such as the Centers for Disease and Control and Prevention<sup>45</sup> for individuals at risk or for the general population by Health Canada<sup>46</sup> to avoid social contact during the peak of the COVID-19 outbreak. It is likely that many individuals have stocked up on unhealthful food items that will eventually be consumed. Therefore, clearer guidelines and recommendations about what foods to purchase are needed.

Although there is some lack of clarity and guidance regarding obesity as a risk factor for COVID-19,<sup>47</sup> substantial preliminary data demonstrate that higher body mass index is a considerable risk factor for hospitalization and development of severe pneumonia.<sup>48–51</sup> In fact, a systematic review and meta-analyses showed that 50% of the adult patients infected with the Middle East coronavirus presented with hypertension and diabetes, while obesity was present in 16% of the cases.<sup>52</sup> Moreover, a recent study found a significant inverse correlation between body mass index and age: young individuals admitted to hospitals were more likely to have obesity. The study suggested that obesity could shift the incidence of severe COVID-19 disease to younger ages in countries where the prevalence of obesity is high.<sup>48</sup>

Obesity restricts respiration, weakens immune responses, and is proinflammatory. It is also associated with an increased risk of diabetes mellitus, cardiovascular disease, and kidney disease, all of which contribute to increased vulnerability to pneumonia-associated organ failure.<sup>53</sup> Thus, healthy weight loss could be a good strategy to reduce the risk of COVID-19 complications. Although none of the institutions mentioned weight loss in their guidelines, 3 of them highlighted the importance of avoiding weight gain. Specific guidelines for

obese individuals are nonetheless needed to promote gradual weight loss without compromising the body's lean mass. Considering the difficulty to achieve significant weight loss through physical activity during the pandemic, protein intake of around 30% of energy requirements may be considered for adults under energy-restricted diets. This level of protein intake can prevent or attenuate the loss of lean muscle mass while also promoting greater satiety during weight loss.<sup>54</sup> In their discussion of nutritional recommendations during COVID-19 quarantine, Muscogiuri et al<sup>4</sup> highlighted the role of tryptophan, an amino acid and a precursor of serotonin, in the regulation of satiety and caloric intake, suggesting protein-rich foods such as milk, yogurt, seeds, and nuts as good sources. It is worth noting that web-based weight-loss approaches are becoming popular and are effective for patients with obesity.<sup>55</sup> Such tools may be useful during the COVID-19 pandemic.

Probiotics were recommended by only one institution,<sup>11</sup> which did not provide a specific amount or examples of food sources. Probiotics are defined as “live microorganisms that, when administered in adequate amounts, confer a health benefit on the host.”<sup>56</sup> They can act through diverse mechanisms, including modulation of immune function, production of antimicrobial compounds and organic acids, improvement of gut barrier integrity, formation of enzymes, and interaction with resident microbiota.<sup>57</sup> Studies of probiotic species belonging to the *Lactobacillus* and *Bifidobacterium* genera have shown promising results regarding improved immune function.<sup>58</sup> Fermented dairy products might be a good option to improve the gut microbiota, although further studies are needed to better elucidate the modulatory mechanisms of the microorganisms in these foods.

Only one agency provided guidance on alcohol consumption. The Food and Agriculture Organization of the United Nations<sup>20</sup> recommended that alcohol intake be limited, but no specific amounts were provided. Excessive alcohol consumption is associated with reduced host immunity to viral infections and increased susceptibility to tuberculosis and bacterial and viral pneumonia in humans and animals.<sup>59</sup> On the other hand, some benefits of moderate alcohol consumption have been reported, including reduced risk of cardiovascular disease, alleviation of acute stress, improved mood, and increased relaxation.<sup>60</sup> Current guidelines for moderate intake recommend no more than 1 drink per day for women and no more than 2 drinks per day for men.<sup>5</sup> It should be noted that individuals who do not drink alcohol should not start drinking.

Finally, generic terms and phrases such as “healthy diet,” “variety of foods in each group,” “variety of fresh and unprocessed foods,” and “varied diet” were

observed in the majority of the documents. These messages might not be clear enough to encourage people to make healthy food choices. Specific recommendations, including examples of food and instructions for food preparation, would improve the public health message.

### Dietary supplementation

All documents reported that there are currently no known supplements to prevent COVID-19. Only 2 documents mentioned that it might be possible to use supplements to meet dietary recommendations.<sup>11,19</sup> Some vitamins and minerals improve immunity; however, the idea that more is better is a misconception. Megadoses of vitamins and minerals can induce toxic and adverse effects<sup>61,62</sup> or interact with medications, leading to enhanced or reduced pharmacological effects.<sup>63</sup>

On the other hand, it is important to note that Dietary Reference Intakes have been established for healthy individuals and are based on a diet providing 2000 kcal/d.<sup>64</sup> Thus, healthcare professionals should individualize dietary plans by considering factors that can increase nutrient requirements, such as specific diseases/conditions, medications, dietary patterns (eg, vegetarianism), and exercise intensity. For this purpose, the range from the Recommended Dietary Allowance to the Tolerable Upper Intake Level can be used to optimize the dietary plan.<sup>65</sup>

The Brazilian Association of Clinical Nutrition<sup>11</sup> reported that vitamin C supplementation may be useful for individuals at risk of respiratory viral infections. Vitamin C is a recognized antioxidant nutrient that can enhance chemotaxis, phagocytosis, generation of reactive oxygen species, and, ultimately, microbial killing.<sup>66</sup> However, a systematic review involving 10 708 participants showed that doses of vitamin C exceeding 1 g/d were not beneficial in reducing the incidence of colds among the overall population.<sup>67</sup> On the other hand, such doses might be effective in reducing the duration of colds by 8% to 18%. In addition, vitamin C may be useful to prevent the development of colds in people exposed to brief periods of intense physical activity<sup>67</sup> or to cold temperatures.<sup>68</sup>

Vitamin D is another antioxidant that has been associated with a reduction in pulmonary infections.<sup>69,70</sup> Evidence that vitamin D can prevent or treat influenza is inconclusive,<sup>71</sup> but vitamin D status has been associated with the severity of COVID-19.<sup>31</sup> Potential mechanisms include increased secretion of antimicrobial peptides, decreased production of chemokines, inhibition of dendritic cell activation, and altered T-cell activation.<sup>72</sup>

None of the documents reviewed here suggested vitamin D supplementation as preventive therapy against COVID-19. However, Rhodes et al<sup>31</sup> suggested that countries south of latitude 35° north have low population mortality, which might indicate a role of vitamin D in determining outcomes from COVID-19. When deficiency is detected, oral supplementation with doses between 2000 and 4000 IU/d is indicated.<sup>11</sup> Although a higher dose has been recently proposed with the aim of reducing the risk of infection (vitamin D<sub>3</sub>, 10 000 IU/d for a few weeks to rapidly raise 25(OH)D concentrations, followed by 5000 IU/d),<sup>73</sup> this is still controversial and contradicts other recommendations. Since it is not feasible to recommend biochemical analysis of vitamin D levels during a pandemic, targeting vulnerable populations for vitamin D supplementation can mitigate the health risks associated with COVID-19, especially since vitamin D deficiency has been shown to correlate with hypertension, diabetes mellitus, obesity, and darker skin pigmentation.<sup>29</sup> Although it may be controversial, vitamin D supplementation to prevent deficiency may, at the very least, provide benefits by sustaining bone mass during lockdown.

Zinc and selenium are antioxidant micronutrients often considered for supplementation.<sup>11,28</sup> Zinc is a cofactor of superoxide dismutase, an enzyme present in the mitochondria and cytosol of cells that suppresses oxidative stress. Excess zinc, however, also causes cellular oxidative stress.<sup>74</sup> A narrative review showed ample evidence of the antiviral activity of zinc (10 mg/kg of body weight, up to 600 mg/d total) against a variety of viruses, such as influenza.<sup>75</sup> In addition, zinc is critical in generating both innate and acquired (humoral) antiviral responses. However, the authors concluded that further research is needed on the antiviral mechanisms and clinical benefits of zinc supplementation as a preventative and therapeutic treatment for viral infections.<sup>75</sup> A recent study suggested that the elderly are at risk for zinc deficiency, which increases susceptibility to infections such as pneumonia. Zinc supplementation (ie, elemental zinc, 30 mg/d) might be adequate to improve immune function and to reduce the risk of infections in this group.<sup>76</sup>

Selenium has been found to increase the activity of glutathione peroxidase, another antioxidant enzyme, and to augment a number of host immune responses, including interferon  $\gamma$  production, T-cell proliferation, antigen stimulation, and natural killer cell activity.<sup>77</sup> In fact, an experimental study with mice and influenza virus showed that selenium deficiency led to more severe disease and an increased proinflammatory immune response, resulting in increased pathology in the lungs.<sup>78</sup> Selenium is an important trace element that can be



found in nuts, breads, grains, meat, poultry, fish, and eggs and is easily obtainable from dietary sources (see the *Dietary recommendations* section).

In summary, it is preferable to obtain antioxidants from food rather than from supplements. However, supplements are recommended for individuals who have specific challenges in meeting dietary requirements. The key message regarding dietary supplements is that individuals should not rely on supplements to prevent COVID-19. Further studies into the effects of vitamin and mineral supplementation on outcomes related to COVID-19 (eg, disease severity, inflammatory status, hospitalization, death, etc) are warranted. Currently, several clinical trials on vitamin D (n = 21), vitamin C (n = 15), zinc (n = 15), and selenium (n = 1) supplementation are under way ([www.clinicaltrials.gov](http://www.clinicaltrials.gov)). It is hoped that the results of these studies will lead to a better understanding of the relationship between micronutrients and COVID-19.

## Breastfeeding

Breastfeeding provides a multitude of benefits for both mother and child. Breast milk contains important antibodies that benefit the child's immune system, protecting against viral and bacterial infections.<sup>7</sup> According to the World Health Organization, breastfeeding must be exclusive until 6 months of age (no water, other fluids, or solids) and continued until 2 years of age or beyond.<sup>79</sup> Only 6 of the 13 documents included in this review addressed this topic.<sup>15,18,19,21,23,25</sup> All recommended that breastfeeding be maintained during the COVID-19 pandemic, even in women diagnosed with the disease. However, good hygiene practices are recommended, including mask wearing, handwashing before and after touching the infant, and disinfecting frequently used surfaces.

## Food hygiene

Approximately 54% of the documents selected for this review included guidance on food hygiene.<sup>14,16,18–20,23</sup> There is currently no convincing evidence that food or food packaging is associated with the transmission of COVID-19.<sup>18,20,23</sup> The risk of fecal-oral transmission, while low,<sup>80</sup> can persist even after viral clearance from the respiratory tract. This highlights the need for routine stool testing and transmission-based precautions for hospitalized patients<sup>81</sup> and probably for those recovering at home. All documents emphasized the importance of adequate personal hygiene when handling food, highlighting the need for frequent handwashing with soap and water or alcohol-based hand sanitizers.

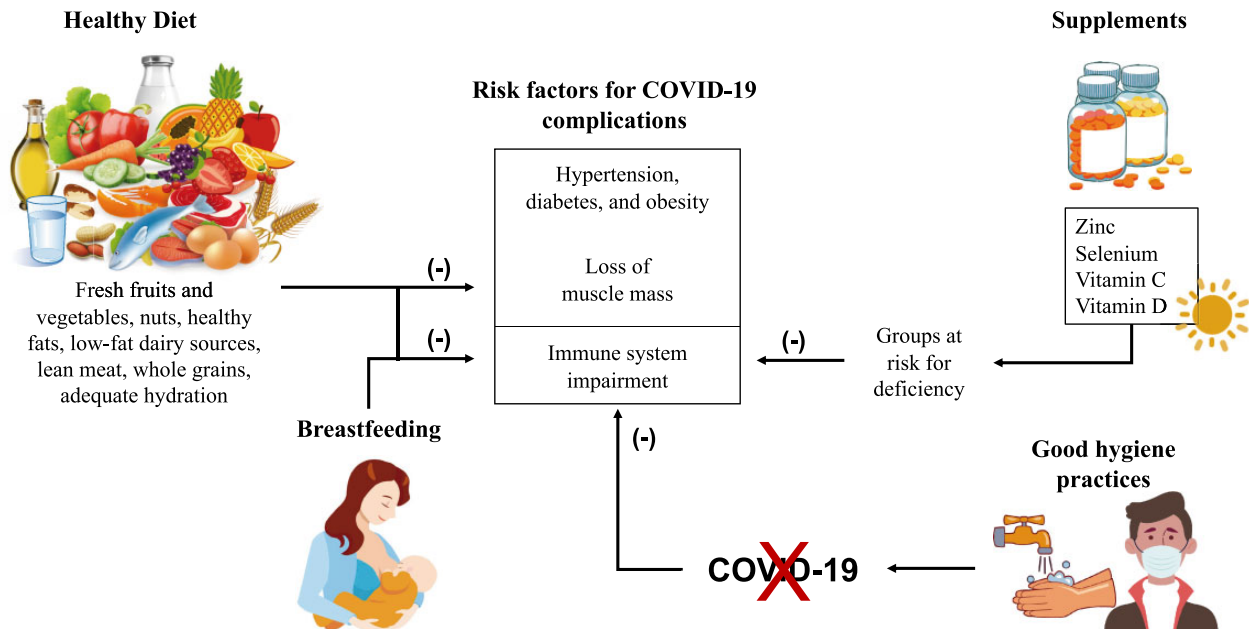
In food and beverage stores, the greatest risk of contamination is through contact with other people and “high touch” surfaces such as food scales, shopping-cart handles, and elevator buttons.<sup>19</sup> Unlike some viruses that can live on food or other surfaces for several days, SARS-CoV-2 can survive on metal or plastic surfaces for 3 days and on cardboard surfaces for 1 day.<sup>82</sup> Infectious disease authorities in several countries are recommending the use of soap or alcohol-based hand sanitizer for handwashing, reinforcing the importance of strict hygiene measures to prevent the spread of contamination.<sup>80,83</sup>

According to the European Food Safety Authority,<sup>19</sup> there is no need to disinfect food packaging itself, as long as some precautions are taken: (1) wash hands for 20 seconds with soap and water before and after grocery shopping, unpacking foods, and after receiving delivered food; (2) maintain a safe distance (1 to 2 meters) from other people when shopping; (3) do not go shopping when sick; instead, when possible, order groceries online or have family members or friends help with shopping; (4) avoid touching foods unless you plan to buy them; (5) limit trips to the supermarket by planning meals; (6) cover your mouth and nose with a tissue or your sleeve when coughing or sneezing, and wash hands afterward; and (7) after touching surfaces, avoid touching your face, nose, and mouth until after hands have been washed.

In contrast, the Brazilian Association of Clinical Nutrition<sup>13</sup> advocates the use of hygiene practices when handling food packaging of purchased items. They recommend washing food packages with soap and water and spraying with 70% alcohol or a chlorinated solution before storing them. Fresh foods such as vegetables and fruits can be frozen after they are sanitized with sodium hypochlorite. Blanching of vegetables is also suggested to reduce spoilage.

The Food and Agriculture Organization of the United Nations<sup>20</sup> proposes the use of 5 core messages for safer food: (1) keep food clean; (2) separate raw and cooked foods; (3) cook food thoroughly; (4) keep food at safe temperatures; and (5) use safe water and raw materials. Although SARS-CoV-2 can survive in water for a short time, the European Food Information Council<sup>19</sup> has noted that the virus has not been detected in drinking water, which is generally subjected to several treatment steps, making both tap water and bottled water safe for human consumption and food hygiene. The main concern lies in low- to middle-income countries, where access to treated water may be limited or nonexistent.

Figure 1 describes the rationale behind the dietary guidance and the personal hygiene practices recommended during the COVID-19 pandemic, along with



**Figure 1 Rationale for dietary recommendations during the coronavirus disease 2019 (COVID-19) pandemic.** Key nutrients that support the immune system can be obtained through dietary components that include fresh foods (eg, fruits and vegetables), fish, lean meat, dairy, water and other non-sugary beverages, and healthy fats. A healthy diet can also decrease the risk of, or help control, hypertension, diabetes, obesity, and muscle atrophy, which are all considered risk factors for COVID-19 complications. There are no known supplements that can prevent COVID-19; however, in populations at risk of deficiency, supplements can mitigate the public health risks associated with COVID-19. Breastfeeding benefits an infant’s immune system, protecting against viruses and bacterial infections. The use of personal protection, such as masks, along with good hygiene practices, such as frequent handwashing with soap and water or alcohol-based sanitizers, can prevent COVID-19 transmission and immune system impairment. Symbol: (-): inhibitory effect.

the potential mechanisms linking diet and the prevention of COVID-19 complications.

breastfeeding should be encouraged, even in women diagnosed with COVID-19.

## CONCLUSION

This review summarizes recent scientific literature and existing recommendations from national and international nutrition agencies on an optimal diet, vitamin and mineral supplementation, and good hygiene practices for food preparation during the COVID-19 pandemic. The findings can be used to help dietitians and healthcare professionals better address dietary recommendations during the COVID-19 pandemic.

Guidance related to the safe handling of food, from production to consumption, is critical to reduce the risk of viral dissemination. The general recommendation is to consume a diet based predominantly on fresh foods such as fruits, vegetables, whole grains, low-fat dairy sources, and healthy fats (olive oil and fish oil) and to limit intakes of sugary drinks and processed foods high in calories and salt. Dietary supplements (ie, vitamins C and D, zinc, and selenium) should be administered to individuals with, or at risk of, respiratory viral infections or in whom deficiency is detected. Breast milk is the safest and healthiest food for infants, and

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