

Nutritional Intervention Based on Novel Coronavirus Postinfection Syndrome

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Abstract. When the novel coronavirus pneumonia (COVID-19) pandemic broke out, the focus of global efforts was to curb the spread of the virus to avoid infection. The COVID-19 epidemic has not only caused infection on people, but also adverse effects. Though the spread of COVID-19 has been well controlled nowadays, its potential sustained impact on the human body cannot be ignored, and its overall health needs continued attention. The World Health Organization (WHO) has uniformly named various symptoms that persist after COVID-19 infection as novel coronavirus post infection syndrome (PCS). PCS has various impacts on patients, such as respiratory dysfunction, muscle loss, intestinal microbiota disorder, physical dysfunction and mental health impact. Proper nutritional assessment is one of the key links in treating or preventing the progression of PCS patients. Additionally, individualized nutritional advice has been shown to be a successful method of helping patients recover. To learn more about the function of nutrients and their supplementation in PCS and the clinical data supporting those claims, see this review, in order to provide practical guidance and suggestions for nutritionists and tailor personalized dietary interventions for PCS patients.

Keywords: COVID-19, Post Infection Syndrome, Nutritional intervention.

1. Introduction

A serious crisis has been brought on by the new coronavirus pneumonia (COVID-19) epidemic. The World Health Organization (WHO) estimates that as of March 12, 2023, there were 6.8 million fatalities and 760 million confirmed illnesses globally [1]. Among the people infected with novel coronavirus (SARS-CoV-2), many still have persistent symptoms several months after the initial diagnosis, such as fatigue, sleep disorder, anxiety, dyspnea, etc., which has adverse effects on their life [2]. WHO named this syndrome novel coronavirus post infection syndrome (PCS). During the COVID-19 pandemic, the nutritional composition of people's intake is very unreasonable, which increases the possibility of PCS as well as reinfection. There are several reasons giving rise to the unreasonable dietary intake. First is that the supply of fresh food was limited due to the blockade of logistics. Secondly, unhealthy lifestyle, which is caused by limited movement and black mood people suffered during the epidemic isolation, is responsible for the formation of bad eating habits. Furthermore, COVID-19 infection has brought about intestinal flora disorder, anorexia and other symptoms, which also lead to malnutrition.

Intervention in PCS through nutrition is currently a recognized approach in clinical practice, which means that reasonable intake of nutrients can repair organ damage to a certain extent, thereby achieving the effect of treating COVID-19 and preventing PCS. However, there is currently a lack of systematic elaboration on the specific relationship between the two, or the efficacy or safety of specific measures in individualized symptoms. Therefore, this article will discuss food nutrition combinations based on PCS, in order to provide theoretical basis for delaying the progression or prevention of diseases.

2. Impact of PCS

In April 2022, according to the WHO, it is "a series of symptoms that appear three months or more after the COVID-19 infection may be confirmed or has been confirmed, which last for at least two months and are not explained by other diagnoses, have an impact on daily life, and may recur over time." More than one third of COVID-19 patients have reported that this symptom has a long-term performance of more than 28 days. For such patients with COVID-19, they are more likely to suffer from COVID-19 than those with COVID-19. For people with toxicity, the characteristics are more obvious, that is, they suffer from other common symptoms and maintain them for a long time. The main manifestations of the disease are respiratory dysfunction, physical dysfunction and psychological dysfunction, long-term or permanent respiratory organ damage in the rehabilitation process of patients infected with novel coronavirus; Severe catabolism, decreased muscle protein synthesis, and loss of skeletal muscle mass and function leading to sarcopenia; The increase in energy and nutritional needs of the body leads to disruption of gut microbiota; Long term physical dysfunction; Psychological health issues caused by closed isolation and changes in lifestyle habits.

2.1. Causing Respiratory Dysfunction

SARS-CoV-2 enters the lungs by expressing ace2 type 2 lung cells, which then sets off a rapid systemic inflammatory response and cytokine storm, activates local dendritic cells, and causes activated T lymphocytes to release antiviral cytokines, which in turn causes lung damage [3]. The 6-minute walk test (6MWT) is a crucial metric for assessing the capacity for cardiovascular exercise. Patients with COVID-19 were observed for 3 months following discharge, and it was discovered that they had considerably lower 6MWT distances than healthy individuals of same age; However, patients with severe conditions during the acute infection period showed a greater reduction in 6MWT distance after 6 months of discharge [4].

2.2. A Decrease in Muscle Mass is Known as Sarcopenia

Myopenia is a progressive systemic disease that may cause loss of muscle mass and function. Acute myopenia can occur during the infection of COVID-19, especially in elderly patients, which has a direct impact on the functional recovery after COVID-19 [5]. During the period from April 21, 2020 to February 28, 2021, 541 COVID-19 patients (with an average age of 53.1 years) officially recovered from COVID-19, 274 (51%) of them were women) were followed up in the day hospital after COVID-19. The findings revealed a significant difference between males and females (15.7% and 23.3%, respectively; $P=0.01$) and a 19.5% incidence of sarcopenia. Between participants with and without sarcopenia, the average number of days from the start of COVID-19 to follow-up was similar (87.5 ± 47.4 vs. 95.3 ± 51.7 , respectively; $P=0.1$). There was no discernible difference in the prevalence rates for patients under 19 and those between 45 and 65 years old, both of which ranged from 14% to 15%; Among subjects aged 65 and above, nearly 40% suffer from sarcopenia [6].

2.3. Disturbance of Gut Microbiota

The direct invasion of intestinal mucosa by virus and the influence of antiviral and anti-infection drugs can lead to changes in the composition of intestinal flora in COVID-19 patients. Imbalance of gut microbiota can lead to ectopic gut bacteria, leading to secondary infections. Epidemiological investigation and analysis of the clinical data of 204 patients with COVID-19 admitted to three hospitals showed that up to 50.5% of patients had digestive system symptoms. After eliminating anorexia, a total of 18.6% of patients had gastrointestinal specific symptoms. The imbalance of intestinal flora could lead to intestinal bacteria heterotopia, leading to secondary infection [7]. Probiotics in the gut microbiota play a crucial role in regulating the immune system. When the virus passes through the skin and mucosal barrier and infects the body's cells, the body mainly resists and clears the virus through the immune system to prevent further harm to the host. Probiotics can

stimulate the immune system of the body, regulate excessive inflammation and immune disorders caused by viral infection through immune responses, and thus play an antiviral role [8].

2.4. Physical Dysfunction

Some COVID-19 patients may develop a condition known as chronic fatigue syndrome (CFS), which lasts for an extended duration and significantly lowers quality of life, even after they have been healed. CFS was developed by the US Centers for Disease Control and Prevention in 1994. During the COVID-19 epidemic, about 70% of the novel coronavirus positive patients in various countries showed different degrees of fatigue, decreased work ability and other symptoms. The prevalence of CFS in China is approximately 1.95% [9]. Regardless of symptoms or the severity of the sickness, a prospective cohort study comprising 312 adult patients (247 self-isolated individuals and 65 hospitalized patients) revealed that 61% of patients had ongoing symptoms six months after their acute infection. After six months, the most prevalent symptoms in COVID-19 self-isolated patients are tiredness (30%), loss of taste or smell (27%), focus problems (19%), memory issues (18%), and dyspnea (15%) [10].

2.5. Psychological Disorders

The psychological impact of PCS is very common, and patients may experience anxiety, depression, post-traumatic stress disorder (PTSD), and cognitive impairment. Three months after infection, 37%, 36%, and 47% of people in the Netherlands with long-term COVID-19 symptoms reported PTSD, anxiety, and depression, respectively, according to an online poll [11]. Another study that examined health-related aspects of life and mental health issues among COVID-19 survivors did a meta-synthesis and systemic review of 21 studies and discovered that the prevalence rates of PTSD, sorrow, and anxiety were 18%, 12%, and 17%, respectively [12]. It is crucial to keep in mind that these acute post-neurological as well as mental sequelae are similar to acute post-ICU syndrome, which is characterized by fresh or severe sensory mental wellness impairments (mostly PTSD, anxiety, and depression) [13]. A relevant global survey by the European Union in 2020 showed that out of nearly 60000 respondents from 40 countries or regions, 30% reported experiencing strong stress and depression symptoms during the pandemic [14]. During the crisis phase, this negative emotion is natural and expected.

3. Treatment of PCS

The nutritional intervention of PCS can produce effects in many kinds of different ways, such as recovery of sarcopenia, alleviate post COVID-19 fatigue syndrome, Regulating gut microbiota and improvement of mental health. Malnourished individuals, such as those lacking protein, vitamin D, and trace elements, can exacerbate inflammation and damage immune function in the body, so making them easier to infection with PCS [15]. Therefore, conducting appropriate nutritional assessments, as well as reasonable nutritional and dietary interventions, is the best way to ensure that patients can recover from their current symptoms. At present, there is no specific treatment method for the long-term syndrome of COVID-19. Targeted treatment, multiple dietary supplements, natural bioactive food supplements and active and healthy lifestyle can fight against the long-term syndrome of COVID-19, and a large part of them have been proved to have therapeutic potential. The use of dietary supplements and natural bioactive food supplements may have a significant impact on the treatment of long-term syndrome of COVID-19 [16].

3.1. Recovery of Sarcopenia

Malnourished patients may experience weight loss and skeletal muscle damage due to insufficient energy and protein intake, leading to gastrointestinal dysfunction, digestive malabsorption, etc., resulting in muscle damage. The digestibility of dietary protein affects the utilization of postprandial amino acids, which are crucial for improving muscle synthesis and metabolism related to oligomyosis.

Muscle protein synthesis rate will decrease with a reduction in plasma amino acid concentration, demonstrating that the plasma's necessary amino acids control this process. Malnutrition is associated with the phenotype of oligomyosis, and in recent years, low muscle mass has also been considered a part of the definition of malnutrition [17]. Ingestion of high-quality protein and amino acids can enhance muscle protein synthesis, improve muscle quality, and enhance muscle strength [18]. Patients with oligomyosis generally need to supplement 1.5 to 2.0g (kg·d) of protein per day, calculated based on daily protein intake and patient weight. In daily life, Intake more high protein foods such as eggs, lean meat, milk, fish, shrimp, etc. It is necessary to avoid vegetarianism as much as possible, which to some extent helps prevent and alleviate muscle loss.

3.2. Alleviate Post COVID-19 Fatigue Syndrome

CFS patients may experience insufficient energy intake due to long-term fatigue and accompanying symptoms such as sore throat, headache, and insomnia, which can affect appetite. This category patients, the energy supply ratio of the three main productive nutrients is also unreasonable, with a relatively high protein intake, low carbohydrates, and high proportion of fat. So, protein can provide energy for the body, so it can serve as the main source of energy and avoid consuming too much fat. For CFS patients, timely and sufficient energy can be obtained through daily food intake to ensure normal metabolism. Carbohydrates, as the most important energy source for the human economy, can quickly provide energy, enhance physical endurance, and improve work efficiency. Supplementing glycopospholipids, antioxidants and vitamins can improve the overall fatigue status of patients with CFS. Therefore, appropriate nutrition supplementation, adequate protein and fat, and essential fatty acids and antioxidants can help provide these nutrients in a balanced diet, and can help control or alleviate the post COVID-19 fatigue syndrome.

CFS patients consume less vegetables and fruits, leading to a decrease in the intake of nutrients such as dietary fiber, vitamin C, folic acid, and magnesium. Dietary fiber can promote intestinal health function. Long term consumption of foods rich in dietary fiber can improve the imbalance of gut microbiota, increase the levels of beneficial bacteria such as Bacteroides and Bifidobacterium, reduce stress reactions in the body, and avoid low-grade inflammation. Rich dietary fiber, vitamin C, and folic acid in fruits and vegetables can reduce CRP and TNF- α , Levels of serum inflammatory markers such as IL-6. Eating different types of fruits and vegetables has a higher ability to scavenge free radicals than eating only one type of fruit or vegetable. Therefore, CFS patient's syndrome can increase their daily intake of vegetables and fruits, choose multiple combinations of fruits and vegetables to increase food diversity, increase intake of unsaturated fatty acids, avoid fast food and processed foods, establish a reasonable dietary structure, and improve fatigue symptoms [19]. In addition, the deficiency of certain nutrients, such as B vitamins, vitamin C, sodium, magnesium, zinc, folic acid, L-tryptophan, essential fatty acids, and coenzyme Q10, may also play an important role in increasing the severity of CFS symptoms and developing treatment for chronic fatigue syndrome by increasing oxidative stress, such as alleviating related fatigue symptoms by consuming foods such as bitter melon, honey, coffee, and tremella.

3.3. Regulating Gut Microbiota

The direct invasion of intestinal mucosa by the virus and the influence of antiviral and anti-infection drugs can lead to changes in the composition of intestinal flora in COVID-19 patients, which is manifested in the reduction of beneficial bacteria such as lactobacilli and bifidobacterial in the intestinal tract. You can consume foods rich in dietary fiber or those that do not bother fermentation. Therefore, patients should consume beans, vegetables, fruits, and nuts for a long time; Consume more plant-based foods, low-fat fermented dairy products, and fish; Avoid consuming beverages with high alcohol content, processed high-fat meat, and soft drinks [20].

3.3.1. Rich in dietary fiber

Usually including vegetables, fruits, and honey, such as leeks, celery, Chinese cabbage, white radish, dragon fruit, kiwifruit, etc. By consuming foods rich in dietary fiber in moderation, a large amount of dietary fiber stimulates the intestinal wall and promotes intestinal peristalsis. Additionally, dietary fiber has a high capacity to absorb water, which can lead to an increase in stools volume, moistening the intestines and supporting the development of good bacteria like bifidobacteria and lactobacilli;

3.3.2. Some fermented foods

Such as yogurt, which contains abundant active lactic acid bacteria and fermentation products. Lactic acid bacteria can produce substances such as vitamins, organic acids, bacteriocins, etc., thereby inhibiting the proliferation of harmful bacteria to a certain extent, and enhancing their digestive function to a certain extent, which is conducive to improving the intestinal microbiota.

3.4. Targeting Mental Health

Many of the trials currently registered address mental health issues in one way or another, and prior psychiatric history is a significant predictor of higher rates of anxiety, depression, insomnia and other problems during home isolation and their persistence [21]. However, there is a lack of direct research on nutrition intervention therapy that directly targets emotions. Additionally, the majority of studies specifically list mental disorder as an exclusion condition. Interventions for those with serious mental illness or those who already have it are lacking. In the long run, COVID-19 is linked to the onset of new mental health issues, however, certain COVID-19 individuals may worsen the course of patients with a history of mental illness and may have an impact on long-term COVID-19 patients [22]. In a similar vein, drug addiction is a frequent comorbidity among individuals with mental illness; yet, other from being an exclusion criterion, drug abuse was not included in any of the registered studies. Interventionists need to be called upon to develop and evaluate intervention measures that combine evidence-based treatment for mental illness and drug abuse with treatment for long-term COVID-19 physiological symptoms, while addressing potential interactions between psychological and physical health. After discharge from hospital, patients with COVID-19 generally have mental health problems, including anxiety, sleep disorders, cognitive disorders and other mental health problems. The duration of hospitalization for COVID-19's acute phase, as well as whether or not mechanical ventilation and intensive care were used, all have a significant influence on mental health. The longer COVID-19 critical care patients are hospitalized, the higher the risk of weakness, post-traumatic stress, anxiety, and depression, as well as the decline in cognitive function and quality of life [23].

Therefore, the dietary nutrition management of its patients should be strengthened. The reasonable allocation of diet can directly or indirectly solve the treatment and nursing problems of patients, promote their early recovery, reduce the time of hospitalization or treatment, and thus reduce the probability of depression and PTSD [24]. In addition, there is not enough research yet on nutritional interventions that directly target mood, and so, this article will not give unnecessary conclusion.

An overall healthy diet supplemented with fruits and vegetables rich in vitamin B, as well as fish oil and other bioactive substances, low in trans fatty acids and refined carbohydrates, can effectively alleviate emotional problems such as depression, enhance mental health, and play an important role in the recovery of post-COVID-19 syndrome [25].

4. Conclusion

In summary, PCS poses a great challenge to the full recovery of COVID-19 patients. A number of studies have proved that nutritional intervention is conducive to restoring muscle mass and improving sarcopenia, regulating intestinal flora, alleviating PCS, and regulating the mental health of patients after infection. These sequelae play important roles in the process of COVID-19 treatment and

rehabilitation. However, due to the shallow understanding of PCS at present, it is impossible to completely cure it. Nutritional diet intervention for PCS patients, including timely nutritional screening and assessment, adjustment of diet structure, and appropriate nutrition supplement, are positive to the immediate treatment and long-time recovery of PCS. However, the current nutritive interventions for PCS need to be further optimized, and the existing studies are small in scale, small in sample size, or lack of pertinence. Clinical exploration should be further strengthened in the future to expand the scale and increase the sample size in order to obtain more favorable evidence-based evidence.

Authors Contribution

All the authors contributed equally and their names were listed in alphabetical order.

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