DOI:10.21608/pssrj.2022.116099.1160

تقييم الحالة التغذوية للمتعافيين من كوفيد –١٩

Nutritional status assessment in patients recovered from COVID-19

سارة أحمد سيد أحمد[١] ، ميادة كمال الدين هاشم[٢]

[١]قسم الاقتصاد المنزلى– كلية التربية النوعية – جامعة بورسعيد – بورسعيد – مصر.

[٢]قسم الأمراض الصدرية، كلية الطب، جامعة أسيوط ، مصر.

sara_elsayed@spcd.psu.edu.eg, maiada.hashem@aun.edu.eg.

تقييم الحالة التغذوية للمتعافيين من كوفيد –١٩

سارة أحمد سيد أحمد[١] ، ميادة كمال الدين هاشم[٢]
[١]قسم الاقتصاد المنزلي- كلية التربية النوعية - جامعة بورسعيد - بورسعيد – مصر.
[٢]قسم الأمراض الصدرية، كلية الطب، جامعة أسيوط ، مصر.
sara_elsayed@spcd.psu.edu.eg, maiada.hashem@aun.edu.eg.

المستخلص:

مرض فيروس كورونا ٢٠١٩ (كوفيد ١٩) هو مرض تنفسي خطير نتج عن الإصابة بفيروس كورونا الجديد (سارس- كوف -٢) وانتشر بسرعة، مسببا جائحة عالمية مع ارتفاع معدلات العدوى والوفيات.وقد أشارت الدراسات الحديثة إلي أن سوء التغذية هو أحد العناصر الأساسية التي قد تكون سبب في بطيء التعافي أو عدم التعافي على الإطلاق، بالنسبة للأشخاص المصابين. الهدف من الدراسة: تقييم الحالة التغذوية للمتعافين من كوفيد ١٩، لمعرفة مدى انتشار نقص/سوء التغذية بينهم. المرضى وطرق البحث: هذه دراسة وصفية مستعرضة للملاحظة تمت علي ٢٧٥ مريضا بالغا في غضون أسبوعين بعد التعافي من الاصابة بـ كوفيد ١٩، خلال الفترة من ٧ مارس ٢٠٢١ إلى ٢٠ مايو ٢٠٢١. وكانت أداة التقييم المستخدمة هي استبيان التقييم التغذية المصغر. النتائج: شملت دراستنا ٢٧٥ مريضاً بعمر ٤٠.١٦ ± ١٣.٧٨ سنة، وكان متوسط دخل الأسرة لما يقرب من نصف المرضى المتعافيين (٤٤.٤%) أكبر من ٣٤٠٠ إلى ٦٥٠٠ جنيه مصري شهرياً. أبلغ ٨٤% من المرضى عن أعراض ما بعد كوفيد ـ١٩. وكان متوسط مؤشر كتلة الجسم ٢٩.٤±٥.٧٠٧ بينما كان ٤٥.١% مصنفون بالسمنة (BIM≥ 30). وتبين ان مستوى الحالة التغذوية الذي تم بواسطة استبيان تقييم التغذية المصغر أن ٥٣.٥% من الاشخاص المتعافيين كانوا معرضين لخطر سوء التغذية بمتوسط درجات (٢.٣١±٠.٦١١) . الخلاصة: لمواجهة جائحة كوفيد ـ١٩، يجب تحديد المرضى الذين يعانون من سوء التغذية عند إدخالهم إلى المستشفى ووضع استراتيجية تستهدف جميع مرضى كوفيد ـ١٩ من أجل توفير الرعاية أو الوقاية لأقلهم تأثرا.

الكلمات المفتاحية:

جائحة كوفيد ١٩، سوء التغذية، تقييم التغذية المصغر ، مؤشر كتلة الجسم .

Nutritional status assessment in patients recovered from COVID-19

Sara A. Sayed Ahme1[1] and Maiada K. Hashem[2]

[1]Home Economics Department, Faculty of Specific Education, Port Said University, Port Said, Egypt

[2]Chest Disease Department, Faculty of Medicine, Assiut University, Assiut, Egypt.

Corresponding authors: Sara_elsayed@spcd.psu.edu.eg & Maiada.hashem@aun.edu.eg

Abstract:

Background: Coronavirus disease 2019 (COVID-19) is a serious respiratory disease that resulted from infection with a new coronavirus (SARS-CoV-2) and has rapidly spread, causing a global pandemic with high rates of infection and mortality. In particular, recent studies have reported how malnutrition is one of the crucial elements that may be predictive of slower recovery or no recovery at all, for the affected subjects. **Aim of the study:** The present study aims to assess the nutritional status of patients recovered from COVID-19, to describe the prevalence of under/malnutrition of these patients. **Patients and methods:** This is a cross-sectional study on 275 adult patients within two weeks post-COVID-19 infection i.e. within 2 weeks after the end of isolation period/recovery) during the period of March 7, 2021, to May 20, 2021. The assessment tool used was the Mini Nutritional Assessment (MNA). **Results:** Our study included 275 patients with age 40.16 ± 13.78 years, the average family income of almost half of included patients (44.4%) was >3400 to 6500 Egyptian pounds per month. Post-COVID-19 symptoms were reported by 84% of the patients. The mean BMI was 29.4±5.707 while 45.1% were obese (BIM≥ 30). The level of the nutritional status assessed by MNA SCORE showed that 53.5% of studied populations were at risk of malnutrition with (**2.31 ± 0.611)** mean scores for all included patients. **Conclusion:** In the face of the COVID-19 pandemic, emphasis must be placed to identify undernourished patients on admission and develop an active strategy in all COVID-19 patients for care or prevention for those least affected.

Keywords: COVID-19 pandemic, malnutrition, Mini Nutritional Assessment, body mass index.

Introduction

Coronavirus disease 2019 (COVID-19) is a serious respiratory disease that resulted from infection with a new coronavirus (SARS-CoV-2). (**Kamal *et al.*, 2021**). The virus has rapidly spread, causing a global pandemic with high rates of infection and mortality (**Cumpstey *et al.*, 2021).** Patients suffered from different symptoms like fever, dry cough, and fatigue which is mild in about 80% of cases, but the severity of the case may progress to develop respiratory distress or respiratory failure, and hence, the need for intensive care unit (ICU) will be increased **(Wu and Mc Googan, 2020).** Since the first cases of COVID-19 were reported in Wuhan, the nutritional status of individuals infected with the virus has not been included in the risk profiles prepared (**Cumpstey *et al.*, 2021**). The nutritional status of individuals is considered an indicator of health status, in addition to being an element of resistance against undercurrent diseases. Furthermore, optimal nutritional status transcends the individual, and poor diet in a population can be considered a group risk factor (**Stefan *et al.*, 2020**). The concept that nutritional status directly impacts the proper functioning of the immune system is not new. Evidence exists on the influence of diet on the immune system and susceptibility to disease (**Marasco *et al.*, 2020**).

According to recent clinical evidence in the COVID-19 pandemic scenario, several aspects have been correlated with more critical patients' admissions to the hospital, higher rate of complications, longer recovery time, and even higher mortality rate. In particular, recent studies have reported how malnutrition is one of the crucial elements that may be predictive of slower recovery or no recovery at all, for the affected subjects (**Calder *et al.*, 2020**). Malnutrition refers to the incorrect intake of both energy and macronutrients (carbohydrates, proteins, fats), as well as to micronutrient (minerals and vitamins) deficiency. In the case of shortage of energy intake, the food energy fails to meet the individual’s needs, whereas micronutrient deficiency refers to a lack of vitamins and minerals which are needed, in small amounts, for healthy growth and development. Although it might seem contradictory, individuals might be overfed in terms of energy but be deficient in one or more micronutrients in their routine diet. Inadequate intake of these nutrients is currently largely diffuse, leading to an impaired resistance to infections and, consequently, to an increase in disease seriousness **(Bold *et al.*, 2020**).

It is known that malnutrition represents a risk factor for severity of and mortality from viral pneumonia since the times of the 1918 influenza pandemic **(Short *et al.*, 2018**). Similarly, the recently described SARS-Cov2 infection (COVID-19) and related pneumonia could be closely associated with malnutrition **(WU *et al.*, 2020) and (Liu *et al.*, 2020)**. Indeed, some features observed in COVID-19 patients are likely to lead to bodyweight loss and malnutrition. These include: symptoms potentially resulting in decreased food intake such as dyspnea, dyspepsia, anosmia, anorexia, dysphagia, nausea, vomiting, diarrhea; hyper-metabolism, and increased energy requirements, as observed in various types of severe infection older age with frailty and various comorbidities **(Bedock *et al.*, 2020).** Also, previous studies showed that patients with severe pneumonia were at risk of protein-energy malnutrition, which severely impaired respiratory muscle contractility and the immune defense system. COVID-19 patients also have some signs of malnutrition such as decreased serum albumin and pre-albumin levels and impaired liver and kidney function. Nutrition risk screening and nutrition support have been recommended for critically ill COVID-19 patients. However, clinical evidence of nutrition risk and its association with clinical outcomes for COVID-19 patients is limited **(Zhao *et al.*, 2021).**

Only a few studies, performed in the Chinese population, have evaluated nutritional status in COVID-19 patients, finding a risk of malnutrition in approximately 80% of them during hospitalization. To the best of our knowledge, no studies are reporting nutritional status at discharge, and no studies evaluating nutritional support in this type of subject **(Ramos *et al.*, 2021).** The nutritional diagnosis and early nutritional management of COVID-19 patients must be integrated into the overall therapeutic strategy, as with any acute case of metabolic attack **(Yuki *et al.*, 2020)** and **(Sohrabi *et al.*, 2020).** Several tools have been proposed for the evaluation of the nutritional status. The Mini Nutritional Assessment (MNA), recommended for the evaluation of nutritional status in patients in healthcare settings, appears ideal for patients with COVID -19, alongside a clinical and Para-clinical evaluation **(Haraj *et al.*, 2021).**

For all the above, an adequate assessment of nutritional status in COVID-19 patients, as well as the prescription of a nutritional treatment adapted to their needs, is essential to achieve a better nutrition status, which will certainly improve clinical outcomes. Therefore, the present study aims to assess the nutritional status of patients recovered from COVID-19, to describe the prevalence of under/malnutrition of these patients.

Methods

Sample of study

This is a cross-sectional study on 275 adult patients within two weeks post-COVID-19 infection i.e. within 2 weeks after the end of isolation period/recovery) during the period of March 7, 2021, to May 20, 2021. Patients were included in the study if they had COVID-19 confirmed infection in the registry (positive COVID-19 polymerase chain reaction (PCR test) or if clinical, laboratory, and radiological criteria suggested that they had COVID-19. They were interviewed in the follow-up clinics or by phone and were asked to fill out an online form. The patients' sample included 121 males and 154 females, with an average age of 40 years (19 -81 years), in Port Said and Assuit Governorates, Egypt.

Questionnaire and score

The evaluation was conducted using a Google Forms survey based on original questions of the full Mini Nutritional Assessment (MNA) questionnaire. The MNA is a validated instrument initially developed to assess nutritional status in elderly patients and is mainly indicated for research settings **(Holvoet *et al.*, 2020).** The tool identifies individuals at risk of malnutrition or malnourishment based on the presence of reduction in food, disease burden, weight loss, body mass index, or reduced mobility **(Kaiser *et al.*, 2009).** The MNA includes 18 items grouped in 4 rubrics: anthropometric assessment [*Body Mass Index* (*BMI*) calculated from a person's weight in kilograms divided by the square of height in meters], weight loss, and arm and calf circumferences); general assessment (lifestyle, medication, mobility, and presence of signs of depression or dementia); short dietary assessment (number of meals, food and fluid intake, and autonomy of feeding); and subjective assessment (self-perception of health and nutrition). The full MNA can be completed in less than 15 minutes. Each answer has a numerical value and contributes to the final score, which has a maximum of 30. With threshold values of ≥ 24 for well-nourished, 17-23.5 for at risk of malnutrition, and <17 for malnourished. The sensitivity, specificity, and positive predictive values according to the clinical status were 96%, 98%, and 97% **(Guigoz, 2006).**

Statistical Analysis

Statistical analyses were performed using IBM- SPSS Statistics Version 20 (IBM Corp, Armonk, NY). Categorical data were presented as numbers and percentages and compared using the $\chi 2$ test. Continuous data were reported as means ± standard deviation (SD) and/or median (min-max) and tested for normality using the Shapiro–Wilkes test. The *t*-test was used when the quantitative data were normally distributed, and the Mann–Whitney test was used when the data were not normally distributed. In all statistical tests, $P \leq 0.05$ was considered statistically significant.

Results

The demographic characteristics of patients recovered from COVID-19 were shown in Table (1). The study included 275 post-COVID-19 patients within 2 weeks after recovery, of the 154 (56%) were females and 121 (44%) were males. The mean age was 40.16 ± 13.78 years while the highest group (31.6%) of the studied population age ranged between 31 to 40 years old. The average family income of almost half of included patients (44.4%) was >3400 to 6500 Egyptian pounds per month.

Clinical characteristics and the nutritional status by MNA SCORE of patients recovered from COVID-19 were shown in Table (2). From such data it could be noticed that regarding the clinical condition of the included population during acute infection, 60.7% of the patients had moderate disease while 24.4% had the mild infection, 12.0% needed hospital admission and 15.6% of them needed oxygen therapy. Only 21.8% of the included population had chronic comorbid conditions. Post-COVID-19 symptoms were reported by 84% of the patients and the most frequent symptoms were easy fatigability followed by cough and loss of appetite/ overeating respectively (38.9%, 13.1%, and 11.6%). The mean body mass index (BMI) of the studied population calculated within 2 weeks after recovery was 29.4±5.707 while 45.1% were obese (BIM≥ 30). The level of the nutritional status assessed by MNA SCORE showed that 53.5% of studied populations were at risk of malnutrition with (2.31 ± 0.611) mean scores for all included patients.

The differences in the level of nutritional status MNA SCORE according to gender, need for hospitalization, need for oxygen, and presence of chronic diseases was illustrated in a Table (3). From such data, it could be noticed that no statistically significant difference in the level of MNA SCORE according to gender or need for hospital admission was detected. On the other hand, there was a statistically significant difference in the same score according to a need for oxygen therapy and the presence of chronic comorbid disease (P-value= 0.002, <0.001 respectively).

On the other side, MNA SCORE level was non-significant correlation with the patient age (r^2=0.0265, y = -0.0407x + 23.809) and severity of COVID-19 infection/duration (r^2=0.0131, y = -0.0787x + 23.074) while the opposite direction with the family income (r^2=0.0122, y = 0.0002x + 21.082). Also, obesity (BMI) level was non-significant correlation with the severity of COVID-19 infection/duration (r^2=0.0018, y = -0.037x + 12.487).

Table 1. Demographic characteristics of patients recovered from COVID-19 (n= 275)

NO.	Demographic variables	Frequency	Relative percentage	Mean ± SD
1	Gender			
	Female	154	56.0	
	Male	121	44.0	
2	Age range (Year)			40.16±13.78
	< 50	64	23.3	
	41 to 50	48	17.5	
	31 to 40	87	31.6	
	21 to 30	70	25.5	
	> 20	6	2.2	
3	Family income (Egyptian pound)			1.71±0.690
	2000 to 3400	116	42.2	
	> 3400 to 6500	122	44.4	
	> 6500	37	13.5	

Table 2. Clinical characteristics and the nutritional status by MNA SCORE of patients recovered from COVID-19 (n= 275)

NO.	Clinical characteristics	Frequency	Relative percentage	Mean ±SD
1	Chronic disease			
	No	215	78.2	
	Yes	60	21.8	
2	The severity of COVID-19 infection			
	Mild	67	24.4	
	Moderate	167	60.7	
	Severe	41	14.9	
3	Hospital admission			
	No	242	88.0	
	Yes	33	12.0	
4	Oxygen therapy			
	No	232	84.4	
	Yes	43	15.6	
5	Persistent symptoms after recovery			
	None	44	16.0	
	Loss of appetite- Overeating	32	11.6	

	Sleep Disorders	30	10.9	
	Confusion	16	5.8	
	Fatigue	107	38.9	
	Loss of taste or smell	6	2.2	
	Dyspnea	4	1.5	
	Cough	36	13.1	
6	Body Mass Index			29.41 ± 5.707
	BIM<18.5 kg/ m^2 (Underweight)	2	0.7	
	BIM= 18.5–24.9 kg/m^2 (Normal weight)	65	23.6	
	BIM=25–29.9 kgm^2 (Overweight)	84	30.5	
	BIM≥ 30kgm^2 (Obese)	124	45.1	
7	MNA SCORE			2.31 ± 0.611
	Normal nutritional status	106	38.5	
	At the risk of Malnutrition	147	53.5	
	Malnutrition	22	8.0	

Table 3. The differences in the level of nutritional status MNA SCORE according to gender, need for hospitalization, need for oxygen, and presence of chronic diseases (n = 275)

Variables		Nutritional Status by MNA SCORE	
		Mean	P-value
Gender	Female (n=154)	131.03	0.065
	Male (n=121)	146.87	
Hospital admission	Yes (n=33)	117.68	0.078
	No= (242)	140.77	
Oxygen Therapy	Yes (n=43)	106.84	0.002*
	No= (232)	143.79	
Chronic disease	Yes (n=60)	105.80	0.001*
	No= (215)	146.99	

Mann-Whitney Test.

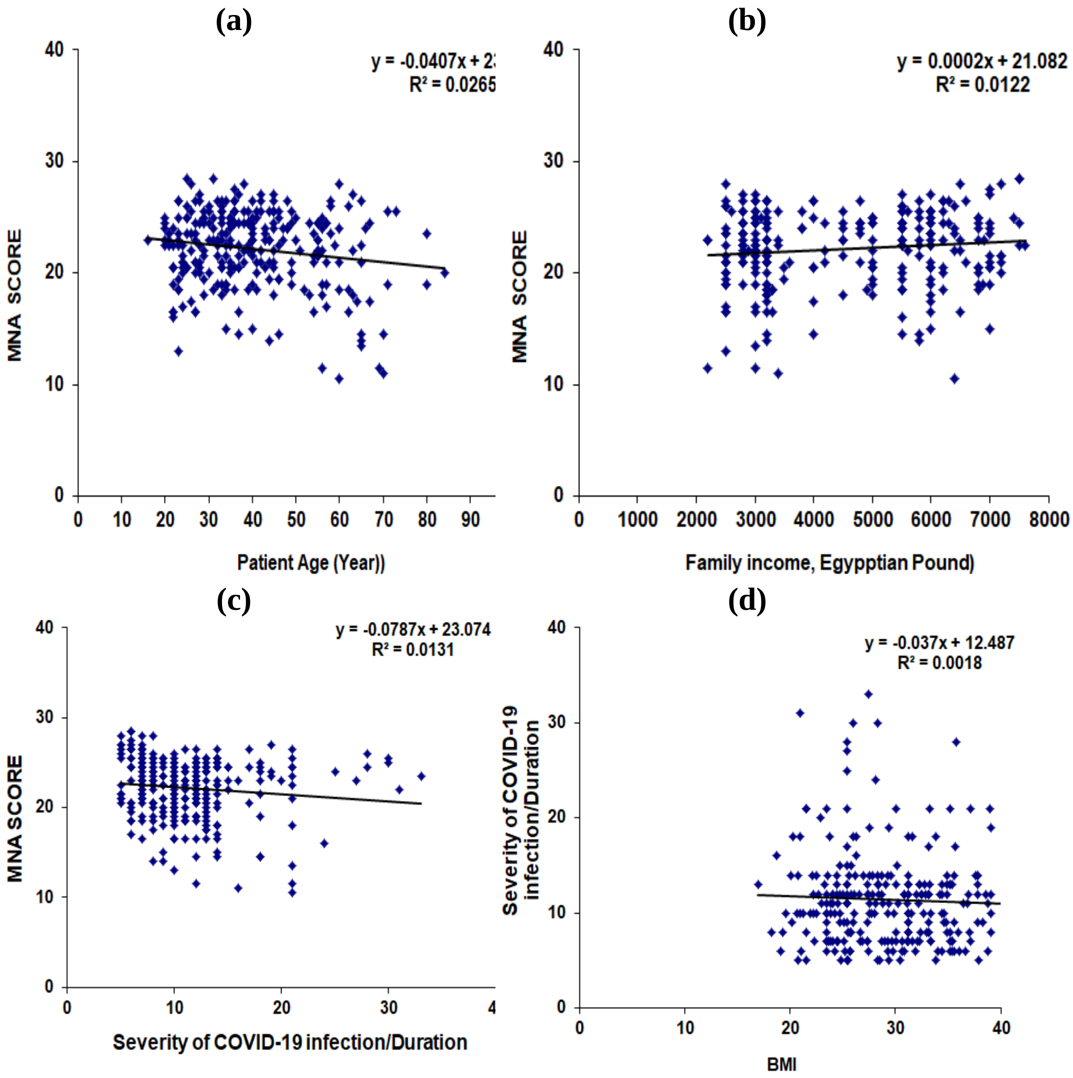

Figure (1): Correlation between different parameters measured and MNA SCORES of patients: a) MNA SCORES vs. patient age, (b) MNA SCORES vs. family income, (c) MNA SCORES vs. severity of COVID-19 infection/duration, and (d) BMI vs. severity of COVID-19 infection/duration.

Discussion

At the end of 2019, a new coronavirus called SARS-CoV-2 appeared in Wuhan, China. It was responsible for the emergence of a new acute respiratory infection now known as "COVID-19". It was declared a pandemic by the **World Health Organization** (WHO) on March 11, 2020 (**Zhu *et al.*, 2020**). As of September 24, 2020, it had reached 30 675675 people and caused 954 417 deaths. In all countries facing the epidemic, the great challenge is the management of severe cases. Based on the risk factors linked to lethality and the development of severe forms, in particularly advanced age and the presence of comorbidities. Egypt was ranked 62nd in the number of people infected with the emerging covid19, out of 215 regions and countries around the world (**Health, 2020**). Frist case of COVID–19 in Egypt infections was discovered on February 14, 2020. Since that date, when the first case of COVID – 19 infections appeared, the cases numbers were increased to exceed 7000 cases by May 2020 with a mortality rate of 6.4% (**Health, 2020).**

Since there is still no specific cure or effective vaccine available for COVID-19, the main means of minimizing disease, death, and other pandemic costs are behavior. This behavior includes social distancing measures such as limiting non-essential trips outside of the home and maintaining adequate social distance (6 feet or greater) from others in public settings (**Centers for Disease Control and Prevention, 2020**). Also, Egyptians are experiencing an increase in the number of chronic diseases, more than a fifth of the Egyptian population suffers from at least one chronic disease; with a require prolonged management which affects their nutritional status, with a major risk of under/malnutrition (**Amine and Sayed Ahmed, 2021).** And to avoid the consequences of a severe form of COVID-19, Assiut university hospital center, which is a tertiary care structure dedicated to the management of the most severe cases, has defined a course of care from the arrival of the patient in the emergency room, hospitalization in the intensive care unit, to their discharge.

In our study, 8% of patients had Malnutrition and 53.5% a risk of undernutrition. Also, the present study with the others reported that a positive correlation was found between poor nutritional status and the long stay in intensive care (**Jiang *al.*, 2020: Silverio *et al.*, 2021)**. Recent studies and guidelines indicate that COVID-19 patients are at high risk of malnutrition (**Amine and Sayed Ahmed, 2021; Haraj *et al*, 2021 and Jiang *al.*, 2020**). Also, **Thibault *et al.*, (2021)** reported that the most severe cases are encountered in particular in patients with a chronic disease, the elderly, or those with co-morbidities. These diseases often mask the underlying protein malnutrition. Patients with COVID-19 should be considered at high risk for malnutrition. Furthermore, **Li *et al.*, (2020)** study of elderly hospitalized patients with COVID-19 reported that 53% of patients suffered from malnutrition. Many studies explained undernutrition during COVID-19 infection by the increase in energy expenditure linked to ventilator work during a severe respiratory infection which induces an inflammatory syndrome and hyper catabolism, and also by the very reduced food intake linked to several factors: anorexia secondary to an infection, respiratory discomfort, anosmia, ageusia and digestive symptoms including diarrhea, vomiting and/or abdominal pain (**Haraj *et al,* 2021; Clemente-Suárez *et al.,* 2021 and Jiang *et al.,* 2020**). Such a hypothesis was confirmed by two Chinese case series of 651 and 1141 COVID-19 patients estimated the prevalence of gastrointestinal symptoms at 11.4 to16% and this is why it is necessary to regularly monitor qualitative and quantitative food intake (**Singer *et al.,* 2019 and Aguila *et al.,* 2020**).

Also, **Thibault *et al.,* (2021)** and, **Li *et al.,* (2020)** reported that as in other severe respiratory infections characterized by an inflammatory syndrome and hyper catabolism, an increase in energy expenditure linked to the work of ventilation, leads to a rapid deterioration of the respiratory muscle function, aggravating the consequences of pulmonary damage. They also found that in severe COVID-19 patients, lymphopenia is common due to the immune response, and antioxidant defenses are worsened by malnutrition leading to an increased risk of complications. So, adequate protein intake is essential in acute infections and malnutrition. Also, amino acids, and in particular glutamine, are essential energy substrates for immune cells such as lymphocytes. Finally, **Van Zanten *et al.,* (2019)** and **Barazzoni *et al.,* (2020)** reported that the modalities of nutritional treatment in COVID-19 patients are the same as in patients hospitalized for other acute pathologies. In the absence of initial undernutrition, the management consists of preventing aggravation by implementing a high-calorie and high-protein diet in COVID-19 patients. In case of moderate undernutrition, a high-calorie and high-protein diet with oral nutritional supplements between meals will be recommended. In case of severe undernutrition (or portions consumed 50%), early enteral nutrition by nasogastric tube, unless contraindication should be recommended **(Bouteloup and Thibault, 2014; Haraj *et al.,* 2021 and Jiang *et al.,* 2020).**

In conclusion, in the face of the COVID-19 pandemic, emphasis must be placed to identify undernourished patients on admission and developing an active strategy in all COVID-19 patients for care or prevention for those least affected. Nutritional treatment methods for COVID-19 patients are the same as those used in patients hospitalized for other acute illnesses/pathologies.

Acknowledgments

The authors acknowledge the great assistance and comments of **Prof. Dr. Yousif Elhassaneen,** Department of Nutrition and Food Science, Faculty of Home Economics, Minoufiya University, Shebin El-Kom, Egypt.

References

Aguila, E. J. T., Cua, I. H. Y., Fontanilla, J. A. C., Yabut, V. L. M., and Causing, M. F. P. (2020). Gastrointestinal manifestations of COVID-19: impact on nutrition practices. Nutrition in Clinical Practice, 35(5), 800-805.

Amine, M. S. and Sayed Ahmed, S. A. (2021). The Effect of Nutritional Education Program on Mitigating Trauma Disorder among Kindergarten Children during COVID19 Pandemic., Scientific Journal of Educational Studies and Research, Volume, (15), Issue (1), February2021, 103-135.

Barazzoni, R., Bischoff, S. C., Breda, J., Wickramasinghe, K., Krznaric, Z., Nitzan, D., ... and Singer, P. (2020). ESPEN expert statements and practical guidance for nutritional management of individuals with SARS-CoV-2 infection. Clinical nutrition, 39(6), 1631-1638.

Bedock, D., Lassen, P. B., Mathian, A., Moreau, P., Couffignal, J., Ciangura, C., ... and Faucher, P. (2020). Prevalence and severity of malnutrition in hospitalized COVID-19 patients. Clinical nutrition ESPEN, 40, 214-219.

Bold, J., Harris, M., Fellows, L., and Chouchane, M. (2020). Nutrition, the digestive system and immunity in COVID-19 infection. Gastroenterology and Hepatology from Bed to Bench, 13(4), 331.

Bouteloup, C., and Thibault, R. (2014). Decision tree for nutritional care. Nutrition Clinique et Métabolisme, 28(1), 52-58.

Calder, P. C., Carr, A. C., Gombart, A. F., and Eggersdorfer, M. (2020). Optimal nutritional status for a well-functioning immune system is an important factor to protect against viral infections. Nutrients, 12(4), 1181.

Centers for Disease Control and Prevention. (2020). COVID-19 How to Protect Yourself and Others. Available from: https://www.cdc.gov/covid19/2019-ncov/prevent-getting-sick/prevention.html. [cited 10 June 2020].

Clemente-Suárez, V. J., Ramos-Campo, D. J., Mielgo-Ayuso, J., Dalamitros, A. A., Nikolaidis, P. A., Hormeño-Holgado, A., and Tornero-Aguilera, J. F. (2021). Nutrition in the Actual COVID-19 Pandemic. A Narrative Review. Nutrients, 13(6), 1924.

Cumpstey, A. F., Clark, A. D., Santolini, J., Jackson, A. A., and Feelisch, M. (2021). COVID-19: A Redox Disease-What a Stress Pandemic Can Teach Us About Resilience and What We May Learn from the Reactive Species Interactome About Its Treatment. Antioxidants and redox signaling, 10.1089/ars.2021.0017. Advance online publication.

Guigoz, Y. (2006). The mini nutritional assessment (MNA®) review of the literature-what does it tell us?. Journal of Nutrition Health and Aging, 10(6), 466.

Haraj, N. E., El Aziz, S., Chadli, A., Dafir, A., Mjabber, A., Aissaoui, O., ... and Afif, M. H. (2021). Nutritional status assessment in patients with Covid-19 after discharge from the intensive care unit. Clinical Nutrition ESPEN, 41, 423-428.

Health, E.M. (2020). [COVID-19 status in Egypt]. Available from: https://www.care.gov.eg/EgyptCare/Index.aspx . Accessed 5 May, 2020.

Holvoet, E., Vanden Wyngaert, K., Van Craenenbroeck, A. H., Van Biesen, W., and Eloot, S. (2020). The screening score of Mini Nutritional Assessment (MNA) is a useful routine screening tool for malnutrition risk in patients on maintenance dialysis. PloS one, 15(3), e0229722.

Kaiser, M. J., Bauer, J. M., Ramsch, C., Uter, W., Guigoz, Y., Cederholm, T., ... and Sieber, C. C. (2009). Validation of the Mini Nutritional Assessment Short-Form (MNA®-SF): A practical tool for identification of nutritional status. JNHA-The Journal of Nutrition, Health and Aging, 13(9), 782-788.

Kamal, M., Abo Omirah, M., Hussein, A., and Saeed, H. (2021). Assessment and characterisation of post-COVID-19 manifestations. International journal of clinical practice, 75(3), e13746.

Li, T., Zhang, Y., Gong, C., Wang, J., Liu, B., Shi, L., and Duan, J. (2020). Prevalence of malnutrition and analysis of related factors in elderly patients with COVID-19 in Wuhan, China. European Journal of Clinical Nutrition, 74(6), 871-875.

Liu, W., Tao, Z. W., Wang, L., Yuan, M. L., Liu, K., Zhou, L., ... and Hu, Y. (2020). Analysis of factors associated with disease outcomes in hospitalized patients with 2019 novel coronavirus disease. Chinese medical journal, 133(9), 1032.

Jiang, Y., Abudurexiti, S., An, M. M., Cao, D., Wei, J., and Gong, P. (2020). Risk factors associated with 28-day all-cause mortality in older severe COVID-19 patients in Wuhan, China: a retrospective observational study. Scientific Reports, 10(1), 1-13.

Marasco, G., Serenari, M., Renzulli, M., Alemanni, L. V., Rossini, B., Pettinari, I., ... and Colecchia, A. (2020). Clinical impact of sarcopenia assessment in patients with hepatocellular carcinoma undergoing treatments. Journal of Gastroenterology, 1-17.

Ramos, A., Joaquin, C., Ros, M., Martin, M., Cachero, M., Sospedra, M., Martínez, E., Sánchez Migallón, J. M., Sendrós, M. J., Soldevila, B., and Puig-Domingo, M. (2021). Impact of COVID-19 on nutritional status during the first wave of the pandemic. Clinical nutrition (Edinburgh, Scotland), S0261-5614(21)00238-7.

Short, K. R., Kedzierska, K., and van de Sandt, C. E. (2018). Back to the future: lessons learned from the 1918 influenza pandemic. Frontiers in cellular and infection microbiology, 8, 343.

Silverio, R., Gonçalves, D. C., Andrade, M. F., and Seelaender, M. (2021). Coronavirus disease 2019 (COVID-19) and nutritional status: the missing link?. Advances in Nutrition, 12(3), 682-692.

Singer, P., Blaser, A. R., Berger, M. M., Alhazzani, W., Calder, P. C., Casaer, M. P., ... and Bischoff, S. C. (2019). ESPEN guideline on clinical nutrition in the intensive care unit. Clinical nutrition, 38(1), 48-79.

Sohrabi, C., Alsafi, Z., O'neill, N., Khan, M., Kerwan, A., Al-Jabir, A., ... and Agha, R. (2020). World Health Organization declares global emergency: A review of the 2019 novel coronavirus (COVID-19). International journal of surgery, 76, 71-76.

Stefan, N., Birkenfeld, A. L., Schulze, M. B., and Ludwig, D. S. (2020). Obesity and impaired metabolic health in patients with COVID-19. Nature Reviews Endocrinology, 16(7), 341-342.

Thibault, R., Coëffier, M., Joly, F., Bohe, J., Schneider, S. M., and Déchelotte, P. (2021). How the Covid-19 epidemic is challenging our practice in clinical nutrition—feedback from the field. European journal of clinical nutrition, 75(3), 407-416.

Van Zanten, A. R. H., De Waele, E., and Wischmeyer, P. E. (2019). Nutrition therapy and critical illness: practical guidance for the ICU, post-ICU, and long-term convalescence phases. Critical Care, 23(1), 1-10.

World Health Organization. (2020). Critical preparedness, readiness and response actions for COVID-19: interim guidance, 4 November 2020 (No. WHO/COVID-19/Community_Actions/2020.5).

Wu, C., Chen, X., Cai, Y., Zhou, X., Xu, S., Huang, H., ... and Song, Y. (2020). Risk factors associated with acute respiratory distress syndrome and death in patients with coronavirus disease 2019 pneumonia in Wuhan, China. JAMA internal medicine, 180(7), 934-943.

Wu, Z., and McGoogan, J. M. (2020). Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. Jama, 323(13), 1239-1242.

Yuki, K., Fujiogi, M., and Koutsogiannaki, S. (2020). COVID-19 pathophysiology: A review. Clinical immunology, 215, 108427.

Zhao, X., Li, Y., Ge, Y., Shi, Y., Lv, P., Zhang, J., ... and Li, X. (2021). Evaluation of nutrition risk and its association with mortality risk in severely and critically ill COVID-19 patients. Journal of Parenteral and Enteral Nutrition, 45(1), 32-42.

Zhu, N., Zhang, D., Wang, W., Li, X., Yang, B., Song, J., ... and Wu, G. (2020). A Novel Coronavirus from Patients with Pneumonia in China, 2019. N Engl J Med, 382, 727-733.