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Original Research Article

Assessment of Adequacy of Nutritional Support in COVID-19 Patients Receiving Oxygen Therapy in Multi Isolation Centers in Khartoum State and its Relation to Outcomes

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Abstract: ***Background:*** Beginning in December 2019, the 2019 novel coronavirus disease (COVID-19) has caused a pneumonia epidemic that began in Wuhan, China, and is rapidly spreading throughout the whole world. Nutrition support has become one of the important treatments for severe and critical patients. ***Objective:*** To assess the adequacy of nutritional support in COVID-19 patients receiving oxygen support. ***Methods*:** A multicenter prospective study enrolled 88 COVID-19 patients receiving oxygen support in Fedail Hospital, Albaraha Hospital, Aliaa Hospital, and Royal Care Hospital during the period from January to April 2021. Data regarding demographics, comorbidities, types of oxygen therapy, vital signs, laboratory investigations, methods of nutrition support, estimated calorie achievement, and outcomes were collected. Nutritional adequacy was assessed by using the Nutritional Risk Screening-2002 (NRS- 2002) test. ***Results*:** Among 88 patients, 50(56.8%) were males and 38(43.2%) were females; their mean age was 67±11 years. CPAP (n=28; 32%) and mechanical ventilation (n=27; 27%) were the main types of oxygen therapies. Estimated calories were achieved in only 36(40.9%) of patients and failure to the achievement of estimated calories was commonly due to hypoxia (n=33; 37.5%) and poor appetite (n=23; 26.1%). About 66(75%) patients were adequately nourished, 16(18.2%) were at risk of malnutrition, and 6(6.8%) patients were malnourished. The mortality was significantly associated with malnutrition (*P. value*= 0.000), and parental feeding modes (*P. value*= 0.000), and underweighted BMI (mean= 17.8 kg/m2; *P. value*= 0.000). Moreover, multi-organ failure was significantly correlated with risk of malnutrition (*P.value*= 0.000), NG feeding (*P. value*= 0.000) and overweighed BMI (mean= 28.8 kg/m2; *P. value*= 0.000). Additionally, mortality and multi-organ failure were significantly correlated with hypoalbuminemia among our study subjects (*P. value*= 0.001). ***Conclusion:*** The rates of malnutrition and risk of malnutrition were 6.8% and 18.2% among COVID-19 patients who received oxygen therapy, respectively. Inadequacy of nutritional support or failure in the achievement of estimated calories among our study subjects were commonly due to hypoxia and poor appetite. Mortality was significantly associated with malnutrition, parental feeding modes, and underweighted BMI. Furthermore, multi-organ failure was significantly correlated with the risk of malnutrition, NG feeding, and overweighed BMI. Both, mortality and multi-organ failure were correlated with hypoalbuminemia.

Keywords: Coronavirus infections, Nutritional Support, Oxygen Therapy, Khartoum, Sudan.

INTRODUCTION

Respiratory syndrome coronavirus 2 (SARS-CoV-2) infections was first reported as a viral pneumonia outbreak in Wuhan, China, in December 2019, and its rapid spread has become a public health challenge [1, 2]. The World Health Organization (WHO) has declared coronavirus disease 2019 (COVID-19) a public health emergency of international concern. As of February 25, 2020, a total of 81,109 laboratory-confirmed cases had been documented globally and WHO recognized Covid-19 as pandemic [3]. Until March 2021, a cumulative total of 116,736,437 confirmed cases of COVID-19, including 2,593,285 deaths, have been reported globally [4]. In Sudan, the first COVI-19 case was detected in March, 2020 also there are more than 31,000 confirmed cases of the coronavirus disease (COVID-19) global and over 1880 deaths as of March, 2021. There is variation in case fatality rate, which in some cities (like Khartoum) was low (3.8%), but in others (like North Darfur) it was very high (31.7%) [5]. The clinical syndrome is nonspecific and characterized by fever, headache and dry cough in the majority of patients, with about a third experiencing shortness of breath. Some patients have other symptoms such as myalgias, sore throat, and diarrhea. A complete or partial loss of the sense of smell (anosmia) has been reported as a potential history finding in patients eventually diagnosed with COVID-19, but this has not been a distinguishing feature in published studies. The median age of patients is between 49 and 56 years, median duration of 20 days. Cases in children have been rare. Although most cases appear to be mild, all patients admitted to the hospital have pneumonia with infiltrates on chest x- ray and ground glass opacities on chest computed tomography. About a third of patients subsequently developed acute respiratory distress syndrome and required care in the intensive care unit. This is particularly true for patients with comorbid conditions such as diabetes or hypertension [6]. Numerous nutrients are necessary for proper immune functioning. Nutritional deficiencies weaken the immune system and increase the invasion, replication, and mutation of viruses. Indeed, the pathogenicity of severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2), the virus that causes coronavirus disease 2019 (COVID-19), is associated with an imbalance in several nutritional elements. Nutritional deficiencies are common among severe and fatal COVID- 19, especially elderly adults and patients with age-related comorbidities such as diabetes and cardiovascular disorders. Hypovitaminosis D, anemia, iron metabolism dysfunction, selenium deficiency, and hypoproteinemia are associated with increased levels of proinflammatory cytokines, disease severity, increased admission to the hospital/intensive care unit (ICU), need for mechanical ventilation, and death among COVID-19 patients [7]. Nutritional status and diet modulate inflammation and immune function and may be adjusted to impact COVID-19 outcome. Respiratory support and clinical nutritional support are important parts of supportive therapy for severe and critical patients. It is well-known that a nutrition risk score (NRS-2002) ≥3 would result in poor prognosis. Up to now, studies on SARS-CoV-2 pneumonia have mainly focused on the clinical characteristics and treatment process of patients. Previous studies have reported that high risk factors for death in patients with SARS-CoV-2 pneumonia are older age, high SOFA score, and D-dimer >1 μg/L. So far, no study has discussed the relationship between nutritional support and clinical outcomes in severe and critical patients infected COVID-19 [8].

MATERIALS AND METHODS

Study Design

This is a multicenter prospective hospital-based study.

Study Period

The study was conducted in the period from January to April 2021.

Study Setting

The study was conducted in Fedail, Albaraha, Aliaa, and Royalcare Hospitals in Khartoum state, these are private hospitals with Covid-19 inpatient services. They provided general medical and critical care services.

Study Population

COVID-19 patients received oxygen support in study areas during the study period.

Study Sample

Total coverage of all COVID-19 patients who fulfill the inclusion criteria of the study. The number of patients was 88 patients during the study period.

Ethical Considerations

An ethical approval was obtained from Sudan medical specialization board (SMSB) and EDC. An ethical clearance and approval from research committee in ministry of health Khartoum state (Research Department) Permission was given by hospital manger in unit’s consultants. Data used anonymously by using numbers designed for the purpose of the study in order to protect patient’s identity. No reference to any individual participant made in study reports. Subject identities were being known only by the study staff. Consideration of All COVID-19 precaution (face mask, Hand hygiene) etc.

DATA COLLECTION

Data collection was carried out by the principal investigator. Data was collected through structured questionnaires consisting of demographics, comorbidities, types of oxygen therapy, vital signs, laboratory investigations, methods of nutrition support, estimated calorie achievement, and outcomes were collected. Nutritional adequacy was assessed by using the Nutritional Risk Screening-2002 (NRS-2002) test.

DATA ANALYSIS

Data were analyzed by using the computer program Statistical Package for Social Sciences (SPSS V. 21.0). The analyzed data is presented in tables and figures designed by Microsoft Excel 2007. Chi-Square test was used for categorical variables and ANOVA for continuous variables and Pearson’s correlation were used. The *P. value* was considered significant at level 0.05.

RESULTS

This study recruited 88 COVID-19 receiving oxygen therapy, They were diagnosed by PCR and HRCT chest. The majority were males and their ages ranged from 40 to above 60 years, their mean age was 67±11 years and most of them were 70(79.5%) aged above 60 years (Table 1). Hypertension (n=61; 69.3%)

and DM (n=58; 65.9%) were the major comorbidities**.** In vital signs, the mean heart rate was 97±17 bpm, SBP 134±22 mmHg, DBP 78±22 mmHg, oxygen saturation 91±6%, respiratory rate 26±7 breath/minute, and temperature 36.6±1.2˚c, and BMI 27.5±5 kg/m2 (Table 2). Regarding laboratory investigations, the mean of hemoglobin was 11±2 g/dl, leucocytes count 12.4±6x103cell/cumm, lymphocytes count 1.7±1.6x103cell/cumm, d-dimer 1029±838, CRP 122±88, albumin 3±0.7 g/dl, blood glucose 166±49 mg/dl, potassium levels 3.6±0.7 mmol/l, calcium levels 8±1.5 mg/dl and magnesium levels 2.1±0.6 mg/dl (Table 3). CPAP and mechanical ventilation were the main types of oxygen therapies in 28(32%) and 27(27%) patients, respectively. As detailed in (Table 4), the methods of nutrition support were oral in48 (54.5%) patients, NG in 29(33%), and IV fluids replacement in 11(12.5%) patients. Estimated calories were achieved in only 36(40.9%) of patients. The reason for not achieving adequate caloric support was commonly hypoxia (n=33; 37.5%) and poor appetite (n=23; 26.1%) Nutritional adequacy was assessed by using NRS-2002**,** in which 66(75%) patients were adequately nourished, 16(18.2%) were at risk of malnutrition and 6(6.8%) patients were malnourished. Regarding outcomes, one-half (n=44; 50%) of patients were improved and normally discharged, 20(22.7%) needed higher O2 therapies, 18(20.5%) had a multi-organ failure, and 6(6.8%) dead. Moreover, the mean duration of the disease was 14±11 days**.** The association between nutritional adequacy and outcomes showed that all improved patients (n=44;100%) and the vast majority of patients who needed higher O2 therapies (n=18; 90%) were adequately nourished, and most of the patients with multi-organ failure (n=13;72%) were at risk of malnutrition and the majority of dead (n=5; 83.3%) were malnourished. The difference was statistically significant (*P. value*= 0.000) (Table 5). (Table 6) showed that most improved patients (84.1%) fed orally, patients with multi-organ failure (66.7%) fed via NG, and dead (83.3%) fed parentally. The difference was statistically significant (*P. value*= 0.000). Most improved and discharged patients (70.5%) achieved estimated calories unlike those with multi-organ failure (0%) and dead (0%). The difference was statistically significant (*P. value*= 0.000) (Table 7). The highest mean albumin levels were encountered in improved and discharged patients (3.28 g/d) while the lowest mean was found among dead (2.2 g/dl). The difference was statistically significant (*P. value*= 0.001). Patients who needed higher O2 therapies were more tended to be obese (BMI= 30.3), multi-organ failure patients were overweighed (BMI= 28.8) and dead were underweighted (BMI= 17.8). The difference was statistically significant (*P. value*= 0.000).

Table 1: The demographic characteristics of COVID -19 received oxygen therapy (N=88)

	N	*%*
Age (Yrs.); M±SD	**67±11**	
<40	4	4.5
40-60	14	15.9
>60	70	79.5
Gender		
Male	50	56.8
Female	38	43.2

Table 2: The vital signs of COVID-19 received oxyge n therapy (N=88)

	Mean	*SD*
HR (bpm)	97	17
SBP (mmHg)	134	22
DBP (mmHg)	78	15
SpO2	91	6
RR (breath/min)	26	7
Temperature (c˚)	36.6	1.2
BMI (kg/m2)	27.5	5

Table 3: The laboratory investigations of COVID-19 received oxygen therapy (N=88)

	Mean	*SD*
Hemoglobin (g/dl)	11	2
TWBC (x103cell/cumm)	12.4	6
Lymphocyte (x103cell/cumm)	1.7	1.6
D-Dimer	1029	838
CRP	122	88
Albumin (g/dl)	3	0.7
Blood glucose (mg/dl)	166	49
Potassium (mmol/l)	3.6	0.7
Calcium (mg/dl)	8	1.5
Magnesium (mg/dl)	2.1	0.6

Table 4: The methods of nutritional support and estimated calorie achievement among COVID-19 received oxyge n therapy (N=88)

	N	*%*
Methods of nutrition support		
Oral	48	54.5
NG	29	33.0
IV fluid replacement	11	12.5
Parenteral	0	0
Estimated calorie requirements achieved		
Yes	36	40.9
No	52	59.1

Reason for not achieving adequate caloric support		
Hypoxia	33	37.5
Poor appetite	23	26.1
Risk of aspiration	13	14.8
Interrupted feeding	12	13.6
Nausea and vomiting	10	11.4
Abdominal distention	9	10.2
Residual feeding	7	8
Food side effect	4	4.5

Table 5: The association between nutritional adequacy and outcomes

Outcomes	*Nutritional adequacy*			*P. value*
	Adequate	***At risk***	***Malnourished***	
Improve	44	0	0	0.000
	100.0%	0.0%	0.0%	
Need higher O2 support (Mechanical ventilator)	18	2	0	
	90.0%	10.0%	0.0%	
Multi-organ failure	4	13	1	
	22.2%	72.2%	5.6%	
Death	0	1	5	
	0.0%	16.7%	83.3%	

Table 6: The association between methods of nutrition support and outcomes

Outcomes	*Methods of nutrition support*			*P. value*
	Oral	***NG***	***Parental***	
Improved	37	7	0	0.000
	84.1%	15.9%	0.0%	
Need higher O2support (mechanical ventilator)	10	9	1	
	50.0%	45.0%	5.0%	
Multi-organ failure	1	12	5	
	5.6%	66.7%	27.8%	
Death	0	1	5	
	0.0%	16.7%	83.3%	

Table 7: The association between estimated calories achievement and outcomes

Outcomes	*Estimated calories achieved*		*P. value*
	Yes	***No***	
Improved	31	13	0.000
	70.5%	29.5%	
Need higher O2 support (mechanical ventilator)	5	15	
	25.0%	75.0%	
Multi-organ failure	0	18	
	0.0%	100.0%	
Death	0	6	
	0.0%	100.0%	

DISCUSSION

Nutrition support has become one of the important treatments for patients with illnesses especially critically patients. In this study, we aimed to describe the adequacy of nutritional support in 88 COVID-19 patients receiving oxygen therapy. This study showed males were predominantly affected by COVID-19 more than females (56.8% vs. 43.2%) with males to female ratio (1.3:1). Also, several previous studies noticed that the incidence of SARS-CoV-2 infection is seen most often in adult male patients (6, 44, 89). This was reported by other studies such as Li *et al*, and Jian-Min J *et al*, [9, 10]. There is no clear explanation as to why men and women would be at different risks of infection; however, some have proposed genetic mechanisms or sex-specific effects [11]. Whether there are differences in risk of infection between men and women requires further research. We wonder if the demographic set up of Sudan is a factor since many males are outdoors working to sustain families. The mean age of the study group was 67±11 years and most of them were 70(79.5%) aged above 60 years. These results were comparable to Marta C *et al*, in Italy (Median=67.5 years) and Jian-Min J *et al*, in

China (Medani= 62 years), [10, 12]. However, lowered means of age were reported by Chinese studies by Huang C *et al*, (Median= 47 years), Li *et al*, (Median= 49 years; 15-89 years), and Chung *et al*, (Median= 51 years), [6, 13, 14]. Among our study cases, hypertension (n=61; 69.3%) and DM (n=58; 65.9%) were the major comorbidities. This could be related to the fact that chronic diseases (such as hypertension and DM) are more prevalent among the old population. Based upon NRS-2002 to assess nutritional adequacy, 6.8% were malnourished and 18.2% were at risk of malnutrition. Malnutrition among COVID 19 patients is explained by the changes induced by the disease itself in the gastrointestinal tract of the patients, along with the elevated sedation required for these patients, which makes it difficult to provide adequate nutritional support. Bearing this in mind, Arkin *et al*, provided information regarding several of the considerations that have to be taken into account when nutrition is provided to critically ill patients of COVID-19 [15]. One such consideration is related to the gastrointestinal hypomotility that is commonly found in these patients, which in turn results in enteral feeding intolerance [15]. In addition, during the hospital stay, the prolonged immobilization, mainly during long stays in intensive care units (ICU), leads to muscle mass losses, making the recovery of these subjects harder. Furthermore, the need for assisted breathing during prolonged periods also contributes to the development of sarcopenia and malnutrition [16, 17]. These findings were comparable to Zhao *et al*, who reported that 16% of the patients were at risk of malnutrition (by NRS-2002), [18]. In contrast, Our findings were lower than studies by Li *et al*, who reported, that 53% were malnourished and 28% at risk of malnutrition (by Mini Nutritional Assessment-MNA) [19], and Liu *et al*, who found 85% of the patients were at risk of malnutrition (by NRS-2002), [20], Malnutrition, the inadequacy of nutritional support or failing in achievement of estimated calories among our study subjects was commonly due to hypoxia (n=33;37.5%) and poor appetite (n=23; 26.1%). In the studies of Briguglio M *et al*, and Zhou S *et al*, the malnutrition is probably due to anorexia, nausea, vomiting, diarrhea (which impair food intake and absorption), hypoalbuminemia, hypermetabolism, and excessive nitrogen loss [21, 22]. These effects are associated with the increase in pro-inflammatory cytokines observed in these patients. Moreover, anorexia can also be related to dyspepsia as reported by Lechien *et al*, [23]. Interestingly, this study demonstrated that mortality was significantly associated with malnutrition, IV fluids replacement modes, and underweighted BMI (mean= 17.8 kg/m2). These findings confirmed that malnutrition is associated with immune dysfunction and thus it is likely to assume that this condition could make individuals more vulnerable to viral infection and poor outcomes [24]. Our result was strongly in agreement with Zhao *et al*, and Elly M *et al*, those found malnutrition appears to be related to increased rates of fatal COVID-19 [18, 25]. Moreover, multi-organ failure was significantly correlated with risk of malnutrition, NG feeding, and overweighed BMI (mean= 28.8kg/m2), this observation was strongly in agreement with j.metabol**.** Noticeably, mortality and multi-organ failure were significantly correlated with hypoalbuminemia among our study subjects. This observation was consistent with the study of Jiaofeng H *et al*, in China who stated that; hypoalbuminemia is associated with the outcome of COVID-19 [26]. However, the mechanisms for hypoalbuminemia in COVID-19 have not been thoroughly studied or explained.

CONCLUSION

Inadequacy of nutritional support or failure to achieve estimated calories among our study subjects were commonly due to hypoxia and poor appetite. Mortality was significantly associated with malnutrition, IV fluids replacement modes, and underweighted BMI. Furthermore, multi-organ failure was significantly correlated with the risk of malnutrition, NG feeding, and overweighed BMI. Both, mortality and multi-organ failure were correlated with hypoalbuminemia

RECOMMENDATION

1) Routine nutritional screening of COVID-19 pa tients is extremely recommended.
2) Implementation of systematic management of t he nutritional intake of COVID-19 patients is r equired to guarantee an optimal nutritional stat us and to improve clinical outcomes.
3) Individualized calories estimation and achieve ment are needed.
4) Further studies to draw up adequate nutritional protocols among our context is highly recom mended.

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REFERENCES

1. Phelan, A. L., Katz, R., & Gostin, L. O. (2020). Th e novel coronavirus originating in Wuhan, China: c hallenges for global health governance. *Jama*, *323*(8), 709-710.
2. Sharma, A., Tiwari, S., Deb, M. K., & Marty, J. L. (2020). Severe acute respiratory syndrome coronav irus-2 (SARS-CoV-2): a global pandemic and treat ment strategies. *International journal of antimicrob ial agents*, *56*(2), 106054.
3. World Health Organization. Coronavirus d i sease (COVID-19) outbreak (https://www. who.int).
4. World Health Organization. Epidemiological Updat e: Coronavirus disease (COVID-19) - 11 March 20 2.
5. Federal Ministry of Health. Directorate General of Emergency and Epidemic Control. COVID-19 Rep

ort.
6. Huang, C., Wang, Y., Li, X., Ren, L., Zhao, J., Hu, Y., ... & Cao, B. (2020). Clinical features of patient s infected with 2019 novel coronavirus in Wuhan, China. *The lancet*, *395*(10223), 497-506.
7. Ali, A. M., & Kunugi, H. (2021). Approaches to nu tritional screening in patients with Coronavirus Dis ease 2019 (COVID-19). *International Journal of E nvironmental Research and Public Health*, *18*(5), 2 772.
8. Yue, X., Li, M., Wang, Y., Zhang, J., Wang, X., Ka n, L., ... & Du, S. (2020). Nutritional support and cl inical outcome of severe and critical patients with COVID-19 pneumonia. *Frontiers in Nutrition*, *7*, 5 81679. doi.org/10.3389/fnut.2020.581679.
9. Li, Q., Guan, X., Wu, P., Wang, X., Zhou, L., Tong , Y., ... & Feng, Z. (2020). Early transmission dyna mics in Wuhan, China, of novel coronavirus–infect ed pneumonia. *New England journal of medicine*.
10. Jin, J. M., Bai, P., He, W., Wu, F., Liu, X. F., Han, D. M., ... & Yang, J. K. (2020). Gender differences in patients with COVID-19: focus on severity and mortality. *Frontiers in public health*,8, 152.
11. Schurz, H., Salie, M., Tromp, G., Hoal, E. G., Kinn ear, C. J., & Möller, M. (2019). The X chromosom e and sex-specific effects in infectious disease susc eptibility. *Human genomics*, *13*(1), 1-12.
12. Colaneri, M., Sacchi, P., Zuccaro, V., Biscarini, S., Sachs, M., Roda, S., ... & Bruno, R. (2020). Clinica l characteristics of coronavirus disease (COVID-19) early findings from a teaching hospital in Pavia, North Italy, 21 to 28 February 2020. *Eurosurveilla nce*, *25*(16), 2000460.
13. Li, Q., Guan, X., Wu, P., Wang, X., Zhou, L., Tong , Y., ... & Feng, Z. (2020). Early transmission dyna mics in Wuhan, China, of novel coronavirus–infect ed pneumonia. *New England journal of medicine*.
14. Chung, M., Bernheim, A., Mei, X., Zhang, N., Hua ng, M., Zeng, X., ... & Shan, H. (2020). CT imagin g features of 2019 novel coronavirus (2019-nCoV) . *Radiology*.
15. Liu, L., Geng, X., McDermott, J., Shen, J., Corbin, C., Xuan, S., ... & Liu, Z. (2016). Copper deficienc y in the lungs of TNF-α transgenic mice. *Frontiers in physiology*, *7*, 234.
16. Wernerman, J. (2005). Intensive care unit nutrition –nonsense or neglect?. *Critical Care*, *9*(3), 1-2.
17. Brodsky, M. B., Levy, M. J., Jedlanek, E., Pandian, V., Blackford, B., Price, C., ... & Akst, L. M. (201 8). Laryngeal injury and upper airway symptoms af ter oral endotracheal intubation with mechanical ve ntilation during critical care: a systematic review. *C ritical care medicine*, *46*(12), 2010.
18. Zhou, F., Yu, T., Du, R., Fan, G., Liu, Y., Liu, Z., .. . & Cao, B. (2020). Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. *The la ncet*, *395*(10229), 1054-1062.
19. Li, T., Zhang, Y., Gong, C., Wang, J., Liu, B., Shi, L., & Duan, J. (2020). Prevalence of malnutrition a nd analysis of related factors in elderly patients wit h COVID-19 in Wuhan, China. *European journal o f clinical nutrition*, *74*(6), 871-875.
20. Liu, G., Zhang, S., Mao, Z., Wang, W., & Hu, H. (2020). Clinical significance of nutritional risk scree ning for older adult patients with COVID-19. *Euro pean journal of clinical nutrition*, *74*(6), 876-883. d oi: 10.1038/s41430-020-0659-7.
21. Briguglio, M., Pregliasco, F. E., Lombardi, G., Pera zzo, P., & Banfi, G. (2020). The malnutritional stat us of the host as a virulence factor for new coronav irus SARS-CoV-2. *Frontiers in Medicine*, *7*, 146.
22. Zhou, S., Ye, B., Fu, P., Li, S., Yuan, P., Yang, L., ... & Yan, A. (2020). Double burden of malnutritio n: examining the growth profile and coexistence of undernutrition, overweight, and obesity among sch ool-aged children and adolescents in urban and rura l counties in Henan Province, China. *Journal of ob esity*, *2020*.
23. Lechien, J. R., Chiesa-Estomba, C. M., De Siati, D. R., Horoi, M., Le Bon, S. D., Rodriguez, A., ... & Saussez, S. (2020). Olfactory and gustatory dysfun ctions as a clinical presentation of mild-to-moderat e forms of the coronavirus disease (COVID-19): a multicenter European study. *European Archives of Oto-rhino-laryngology*, *277*(8), 2251-2261.
24. Fernández-Quintela, A., Milton-Laskibar, I., Trepia na, J., Gómez-Zorita, S., Kajarabille, N., Léniz, A., ... & Portillo, M. P. (2020). Key aspects in nutrition al management of COVID-19 patients. *Journal of c linical medicine*, *9*(8), 2589.
25. Huang, J., Cheng, A., Kumar, R., Fang, Y., Chen, G., Zhu, Y., & Lin, S. (2020). Hypoalbuminemia pr edicts the outcome of COVID-19 independent of ag e and co-morbidity. *Journal of medical virology*, *92* (10), 2152-2158.
26. Palaiodimos, L., Kokkinidis, D. G., Li, W., Karama nis, D., Ognibene, J., Arora, S., ... & Mantzoros, C. S. (2020). Severe obesity, increasing age and male sex are independently associated with worse in-hos pital outcomes, and higher in-hospital mortality, in a cohort of patients with COVID-19 in the Bronx, New York. *Metabolism*, *108*, 154262.