Journal of Population Therapeutics & Clinical Pharmacology

Impact of COVID-19 pandemic on cardiac, respiratory and mental health through collaboration with physician, psychologist, Nursing, Nutritional and Epidemiological specialist

Ghalib Nasser Mobark Aldawsari [1], Saud Nahed Saud Aldawsari [2], Eisa Nazzal Ali Alatawi [3], Tareq Soliman Nazzal Alatawi [4], Ashraf Mohamed Ibrahim ALjaber [5], Sulaiman Qasem Saleem Alatawi [6], Majed Ali D Al Homaidhy [7], Sara Hassan Albeladi [8], Nahlah Mubark Alotaibi [9], Naif Dawas Talaa Alharbi [10], Zahra Sadeq Alnasser[11], Saeed Alwuayli Saeed Alshahrani [12].

1. General Practitioner, Wadi Al Dawasir Hospital
2. Family Physician, Salehiya Health Care Center, Wadi Al Dawasir Hospital
3. Nursing Specialist, Al-Qadisiyah Health Center
4. Nursing Specialist, Ministry of Health, Medical Warehouse
5. Nursing technician, Medical Supply Department, Tabuk, Ministry of Health
6. Nursing Specialist, King Fahd Specialist hospital, Tabuk
7. Psychiatry
8. Nursing Specialist
9. Food and Nutrition Specialist، diryah hospital
10. Nursing Assistant, Mental Health Hospital in Hafar Al-Batin
11. Nursing Specialist, Health Gathering in Al-Ahsa, Al-Omran General Hospital in Al-Ahsa
12. Technician Epidemiological Controller, Southern Sector Administration in Bisha Health

Abstract

The COVID-19 pandemic significantly changed the focus of healthcare Team. In susceptible patient populations, these modifications may have had an impact on respiratory, cardiac, and mental health. The long-term effects of COVID-19 are not as well understood, however they can include persistence, sequelae, and other medical issues that last weeks or months after the initial recovery. In particular, as health care providers struggle to combat COVID-19, we also need to determine how the pandemic has affected people's cardiac, respiratory, and mental health. In conclusion, extended COVID represents a multifaceted illness with prolonged and varied symptoms, necessitating individualized care and continuous assistance for individuals experiencing COVID-19 aftereffects. On the other hand, an effective interprofessional team is essential to a crisis response's effectiveness. **Aim:** The purpose of the current systematic review is to locate studies that examine and evaluate the consequences of COVID-19 pandemic on cardiac,

respiratory and mental health through a collaboration with physician, psychologist, Nursing, Nutritional and Epidemiological specialist. **Design:** A systematic review was formed from 32 studies that were included. **Conclusion** The respiratory, cardiovascular, and neurological systems have been intimately associated with the COVID-19 pandemic since its inception. The COVID-19 sequelae are a developing issue in the post-epidemic era. In order to investigate and control the course of the anomalies in the respiratory, cardiac sequelae of COVID-19 and its effect on mental health, A clinical, Nursing, psychological, Nutritional, pandemic control features should be taken into consideration. Careful monitoring of the disease in survivors is necessary**.** **Keywords:** pandemic, healthcare provider, mental status, cardiac and respiratory issue, COVID-19 long effects.

Introduction

The epidemic of COVID-19 has impacted millions of worldwide, which has increased the demand for long-term care for COVID-19 survivors **(Visco et al., 2022)**. In 2019, the coronavirus illness is still going strong and posing a major threat to the world community. On a global scale, lowering the number of virus-related deaths is of utmost importance, and the pandemic has been deemed as an emergency for public health needing prompt response. However, the harmful effects extend beyond what the pathogen is capable of. Furthermore, the mental health of the general populace has suffered as a result of COVID-19 **(Komiyama et al., 2019).**

Caution is advised since the COVID-19 pandemic may cause or worsen cardiovascular problems. Furthermore, there is a documented link between depression and cardiovascular disease, and the COVID-19 epidemic is generating major mental health problems. More specifically, 20% of individuals with heart failure or coronary artery disease also suffer from depression. The relative risk of coronary artery disease increases by 2.69 times when depression is present **(Rugulies.,2002).**

Patients experiencing severe sickness find the virus to be devastating due to its high infectivity. As COVID-19, the World Health Organization designated the illness brought on by this new RNA coronavirus, known as SARS-CoV-2. SARS-CoV-2 often enters the human body through the respiratory system and works its way up to cause systemic illness. About 81% of people have a mild condition, while the remaining people have a severe disease **(Kapoor.,2020).**

The virus mainly affects the epithelium of the small intestine, the airways, and the vascular endothelium, which are organs with high levels of angiotensin-converting enzyme (angiotensin-converting enzyme-2 [ACE2] expression). The heart and circulatory system is is closely impacted, with the lungs being the organ most afflicted. Patients with mild hypoxia are treated with oxygen supplementation at first, while those with severe hypoxia require mechanical ventilation assistance **(NCPE team.,2019).**

Five percent of the positive cases had respiratory failure, septic shock, or multiorgan dysfunction; in half of these instances, there is a fatal outcome. The lungs are the organ most impacted, with

the cardiovascular system trailing closely behind. The kidney and intestines are two other organs that are seriously malfunctioning **(Wang et al.,2019).**

It is now widely acknowledged that extrapulmonary systems, including the neurological and cardiovascular (CV) systems, are also impacted. This results in symptoms that include neuropsychiatric symptoms like depression, anxiety, delirium, sleeplessness, and brain fog, as well as symptoms like brain fog, fatigue, headaches, chest pains, gastrointestinal problems, joint pains, and loss of taste and smell **(Ahmad et al.,2021).**

Particularly during the COVID-19 pandemic, interprofessional collaboration is crucial to patient safety and effective communication. This is because strong teamwork has been crucial in assisting healthcare workers in previous crisis situations **(Goldman and Xyrichis.,2020), (Campoe.,2020).**

Literature Review

(i). Aim of the review

The purpose of the current systematic review is to locate studies that examine and evaluate the consequences of COVID-19 pandemic on cardiac, respiratory and mental health through A Multidisciplinary collaboration with physician, psychologist, Nursing, Nutritional and Epidemiological specialist.

(ii) Study design:

we carried out a systematic review on the impact of COVID-19 pandemic on cardiac, respiratory and mental health with inclusion of original researches, reviews and studies assessing the effect of COVID-19 epidemic on cardiac, respiratory and mental health status through collaboration with physician, psychologist, Nursing, Nutritional and Epidemiological specialist.

(iii) Study selection

Criteria for inclusion and exclusion.

Original research studies evaluating original researches, reviews and studies assessing the effect of COVID-19 epidemic on health status include cardiovascular, respiratory and nervous system and health care union to manage the pandemic through collaboration with physician, psychologist, Nursing, Nutritional and Epidemiological specialist. Studies published in English from July 2002 to march 2024 were considered. Excluded were case reports, conference abstracts, journalistic notes, and publications without peer review and those not focusing on COVID-19.

Methodology

A systematic search of literature was conducted to review the impact of COVID-19 pandemic on cardiac, respiratory and mental health through collaboration with physician, psychologist, Nursing, Nutritional and Epidemiological specialist.

After a review of 6 electronic abstract and citation databases of CINAHIL, PubMed, Medline, Scopus and google scholar. An 881 items were found. 78 full-text publications were examined out of them since 803 of them did not fit the inclusion requirements. The articles eventually included in the systematic review were 32 following additional revision. The studies were in English. The Search terms included "health workers", "intervention", "COVID-19", "cardiac health" "respiratory health", "mental health" "health human resources" "physician redistribution", "nurse

reassignment", The reference lists of relevant papers were manually reviewed in order to find more studies.

Data Extraction and Quality Assessment

The 32 publications that satisfied the inclusion requirements had their data independently examined and abstracted by the review's writers. Primary study objectives, verified patient population, features, inclusion criteria, terminology and terminologies used, and quality issues were among the extracted data. The data from the literature search was evaluated and selected by the authors using methodological, trustworthy, and health worker interventional criteria. Standardized instruments suited for the individual study designs were used to determine the quality among the research that are included. The results of the included research were narratively synthesized.

Systematic Review Results

Three clinical phases characterize a classic COVID-19 infection: stage 1 is an asymptomatic incubation period; stage 2 is a virus-positive period of symptoms; and stage 3 is a severe respiratory symptomatic stage. In the first two stages, the patient may not be contagious, but in the third stage—when the virus load is highest—the patient is highly contagious. Because they inadvertently propagate the illness throughout the community, asymptomatic carriers are to blame for the disease's unpredictable spread **(Kapoor.,2020).**

The frequency of anomalies in lung function was about 20% in a recent meta-analysis of Sixteen cohort studies involving hospitalized patients and follow-up periods longer than one month after release or two months after admission. Diffusion impairment was the most often seen aberration, subsequently restrictive ventilation anomalies **(Long et al.,2021).**

It's interesting to note that respiratory symptoms have been shown in multiple investigations to be unrelated to radiological or functional changes. A subgroup of 390 patients from a large prospective cohort study was examined after a median of 6 months, and no link was observed between chest CT imaging, exercise capacity, lung function, or symptoms **(Huang et al.,2021).**

Multiple studies have inquired the ways that depression increases the probability of coronary artery disease and cardiac failure These processes can be separated into two categories: stress's direct impact on cardiovascular systems and lifestyle modifications' indirect impacts. Increases in inflammatory cytokines, platelet aggregation, oxidative stress, elevated serum cortisol and catecholamine levels, endothelial dysfunction, and autonomic neuropathy are among the direct impacts. Additionally, it's been proposed that respiratory rhythms and emotional variables like psychological stress are negatively impacted by the diaphragm's neuronal governance, which exacerbates heart failure. **(Bordoni et al.,2018).** Indirect processes encompass lifestyle modifications that lead to obesity and smoking, noncompliance with pharmaceutical regimens, and inadequate exercise routines **(Gehi et al.,2005).**

In light of the COVID-19 pandemic, maintaining a healthy lifestyle is essential for mental health management. This include maintaining relationships with loved ones, getting enough sleep, practicing deep breathing, maintaining a nutritious diet, and getting the recommended amounts of physical exercise and sleep from the World Health Organization **(Komiyama et al., 2019).**

A good diet, enough sleep, exercise, and stopping smoking to boost immunity and maintain a healthy lifestyle are all crucial components of the COVID-19 response. To be more precise, eating a diet rich in vegetables, fruits, and whole grain products will strengthen your immune system and help you avoid obesity. You should also try to limit your intake of salt, fat, and sugar. Exercise is especially important during this epidemic since it lowers the probability of cardiovascular diseases and disorders including depression, dementia, and locomotive syndrome according to the study of **(Kluge et al.,2020 and Coelho-Ravagnani et al.,2021).**

Monitoring and analyzing the impacts of COVID-19 on cardiac, respiratory and mental health is crucial to help inform strategic actions to ensure maintenance of access to essential health services throughout the course of the outbreak, and to mitigate threats to health workforce sustainability.

Discussion

COVID-19 in relation with Cardiac and mental health

It is advisable to use caution as the COVID-19 pandemic has the potential to precipitate or worsen cardiovascular disorders. In addition, the COVID-19 epidemic is seriously affecting mental health, and there has long been evidence linking depression to cardiovascular disease. More specifically, depression affects about 20% of people with heart failure or coronary artery disease. An individual with depression has a 2.69-fold higher relative probability of developing coronary heart disease **(Rugulies.,2002).**

The study of (Bordoni et al.,2018) reveals that the probability of coronary artery disease might rise by 1.49 times with even mild depression, such as a low mood. Depression is linked to an elevated risk of heart failure of 2-1-fold. risk of heart failure is associated with depression. At least 25% of people with heart failure experience depression, which makes their New York Heart Association classes worse **(Bordoni et al.,2018).**

Cardiovascular Involvement

Two studies in 2020 mentioned that Myocardial injury in COVID-19 individuals can be caused by direct endothelial injury, thrombi, hypoxia, cytokine storm, or plaque rupture. The COVID-19 virus causes systemic inflammation and a catecholamine surge that elevate the risk of plaque rupture and may cause acute coronary syndrome. In individuals with underlying heart illness, electrolyte disturbances, particularly hypokalemia, can cause hemodynamically severe arrhythmias. **(Tavazzi et al.,2020) (Xiong et al.,2020).**

It's been proposed that patients on ACE inhibitors for hypertension may be more susceptible to acquiring COVID-19 due to the expression of excess ACE receptors. American Heart Association and The American College of Cardiology, are among the cardiac professional organizations that have suggested sticking with previous ACE inhibitors or angiotensin receptor blockers. Myocardial edema has been shown by magnetic resonance imaging in COVID-19 patients **(Inciardi et al.,2020), (American College of Cardiology., 2020).**

The most typical subjective signs are chest discomfort and palpitations According to a study conducted by Frankfurt University Hospital, 60% of COVID-19 survivors continued to exhibit symptoms of myocardial inflammation more than two months after receiving their diagnosis, and 78% of them had altered cardiovascular function **(Puntmann et al.,2020).**

An inflammatory cascade and subsequent fibrosis may be brought on by myocardial injury; additionally, the location and magnitude of this inflammatory response may lead to adverse ventricular remodeling and arrhythmias. According to **Radin et al 2020** COVID-19 patients experienced prolonged relative tachycardia that persisted for an average of 79 days following the onset of symptoms; in other words, 13.7% of patients did not revert to their normal resting heart rate until 133 days had passed.

As well, it has been noted that remote monitoring of a patient's vital signs and degree of physical activity can help prevent heart failure from getting worse and motivate them to have regular checkups. The use of telemedicine applications is crucial in preventing the development of cardiovascular illnesses, as demands to stay at home are enforced in order to manage infection **(Bertagnin et al.,2021).**

Involvement of the Respiratory System

Hypoxia and the pathological results of minimally invasive autopsies on patients can confirm that the lungs, as target organs of the respiratory system, are gradually failing in their function **(D'Errico et al., 2020).** An increasing number of SARS-CoV-2 infections that have been clinically investigated have shown that the virus affects the pulmonary system, resulting in severe respiratory failure as well as extrapulmonary clinical symptoms **(Shi et al.,2020).**

One of the most severe consequences of viral infection-induced enhanced immune responses is respiratory system dysfunction **(Piazza et al., 2020).** In the two studies, the creation of tissue injury markers and the collapse of lung tissue are caused by the activation of defense systems by the cytokine storm, which also stimulates biochemical pathways **(sakr et al.,2020), (Sidarta-Oliveira et al.,2020**).The following are some of the primary related diseases to be highlighted: pneumonia, pulmonary vascular injury , pulmonary embolism, respiratory failure , and post viral pulmonary fibrosis **(Piazza et al., 2020), (Korkmaz et al.,2020).**

All of the SARS-CoV-2 patients in the research had diffuse bilateral alveolar damage (DAD), according to clinical and pathological findings **(D'Errico et al., 2020).** Findings from macroscopic and microscopic necropsies when individuals have a serious COVID-19 infection showed the existence of a significant lung pathology, which is thought to be a common consequence in COVID-19 patients. The secondary acute bronchopneumonia that was present in 78.6% of the patients and may have been the initial cause of death overlapped with the complication. In addition to that primary pathology, thrombotic/thromboembolic vascular occlusions were another significant result **(Grosse et al.,2020).**

The diagnosis of COVID-19 as a systemic disease was confirmed in the two studies of (**Grosse et al.,2020) and (D'Errico et al., 2020).** the risk of cardiac and vascular consequences, such as acute myocardial injury and thrombotic/thromboembolic events that can impact other organs, is increased due to the infection's high lung involvement **(Sidarta-Oliveira et al.,2020)**. It has been noted that secondary acute bronchopneumonia is one of the most frequent consequences in patients with COVID-19 and may be the primary cause of mortality, despite the evidence of histological changes to the condition **(sakr et al.,2020).**

Mental Involvement

COVID-19 typically affects the mental health during the acute stage of the infection. But during the post-COVID-19 phase, neurological and psychological consequences are also common. Particularly, one COVID-19 side effect that is becoming more widely known is post-COVID-19 neurological syndrome (PCNS); as a result, patients with COVID-19 who live past the acute phase require close observation of their cognitive and mental functioning **(Serrano-Castro et al.,2020)**, (**Wijeratne and Crewther.,2020)**.

While a variety of signs have been documented, the most prevalent ones are headaches, dizziness, fatigue, anosmia, amnestic dysfunction, dysexecutive syndrome, ataxia, tetra paresis, and muscle pain **(Nersesjan et al.,2021).** So, in order to prevent long-term neurological issues, rehabilitation is advised **(Raciti and Calabro.,2021).** However, traditional mobility programs provide difficulties for patients in intensive care units. Moreover, COVID-19 has long-term impacts on mood: one-third of people with the virus have clinically severe depression or depressive symptoms. In particular, Observations have shown that these symptoms tend to manifest more frequently in the first 12 weeks following the infection **(Renaud-Charest et al.,2021).**

Consequently, over 97% of the 714 COVID-19 patients in a research by Hai-Xin Bo et al. had symptoms consistent with post-traumatic stress disorders (PTSDs). However, prolonged quarantine isolation is a common experience for COVID-19 patients, which is why anxiety, depression, and sleeplessness are frequently associated with a decline in quality of life **(Bo et al.,2021).**

Systemic inflammation is the physiological basis of depression linked to COVID-19 In particular, the blood–brain barrier's permeability is enhanced by cytokine storm and elevated inflammatory markers. Reduced levels of tryptophan and serotonin are the result, whereas toxics like kynurenine, quinolinic acid, or 3-hydroxykynurenine are increased. These changes promote neurodegeneration, neurotoxicity, and a reduction in synaptic plasticity and neurogenesis **(Lorkiewicz, and Waszkiewicz.,2021).**

Conclusion

The respiratory, cardiovascular, and neurological systems have been intimately pertaining to the COVID-19 pandemic since its inception. The COVID-19 sequelae are a developing issue in the post-epidemic era. Research on COVID-19 has primarily concentrated on the disease's continuous active phase, despite the fact that it is a significant global health concern. Impaired regulation of the RAAS, inflammation, and coagulopathy problems seem to have a significant role a major part in the harm associated with post-COVID-19 syndrome.

When the illness invades the cardiovascular system, it results in significant hemodynamic abnormalities. To prevent nosocomial infections and safeguard healthcare workers' safety, strict personal protective measures are required. To improve long-term COVID-19 outcomes and clinical/public health management, prevention, rehabilitation, and the etiology of the virus's long-lasting negative effects, a thorough investigation into all the factors pertaining to long-term COVID-19 consequences is necessary.

In reaction regarding the COVID-19 epidemic, maintaining A healthy lifestyle is critical to psychological health management. This involves maintaining relationships with loved ones,

getting enough sleep, practicing deep breathing, maintaining a nutritious diet, and getting the recommended amounts of physical exercise and sleep from the World Health Organization.

In order to investigate and control the course of the anomalies in the respiratory, cardiac sequelae of COVID-19 and its impact on mental health, A clinical, Nursing, functional, radiological, psychological, Nutritional, pandemic control features should be taken into consideration. Careful monitoring of the disease in survivors is necessary

References

Komiyama M, Hasegawa K. Coronavirus Disease (2019): Psychological Stress and Cardiovascular Diseases. 14;16: e33.

Visco V, Vitale C, Rispoli A, Izzo C, Virtuoso N, Ferruzzi GJ, Santopietro M, Melfi A, Rusciano MR, Maglio A, et al. (2022) Post-COVID-19 Syndrome: Involvement and Interactions between Respiratory, Cardiovascular and Nervous Systems. Journal of Clinical Medicine. 11(3):524.

Rugulies R. (2002). Depression as a predictor for coronary heart disease: a review and meta-analysis. Am J Prev Med. 23:51–61.

Kapoor MC. Respiratory and cardiovascular effects of COVID-19 infection and their management. (2020). J Anaesthesiol Clin Pharmacol : S21-S28.

Novel Coronavirus Pneumonia Emergency Response Epidemiology Team. The Epidemiological Characteristics of an Outbreak of 2019 Novel Coronavirus Diseases (COVID-19).

Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. JAMA. 2020; 323:1061–9.

Ahmad, M.S.; Shaik, R.A.; Ahmad, R.K.; Yusuf, M.; Khan, M.; Almutairi, A.B.; Alghuyaythat, W.K.Z.; Almutairi, S.B. (2021). "LONG COVID": 25, 5561–5577.

Goldman J., Xyrichis A. (2020). Interprofessional working during the COVID-19 pandemic: sociological insights. J Interprof Care.;34(5):580–582.

Coelho-Ravagnani CF, Corgosinho FC, Sanches FFZ et al.(2021). Dietary recommendations during the COVID-19 pandemic. 79:382–93.

Campoe K. (2020). Interprofessional collaboration during COVID-19.29(September-October 2020;(5):297–298

Rugulies R. (2002). Depression as a predictor for coronary heart disease: a review and meta-analysis. Am J Prev Med. 23:51–61.

Bordoni B, Marelli F, Morabito B et al. (2018). Depression and anxiety in patients with chronic heart failure. Future Cardiol. 14:115–9

Gehi A, Haas D, Pipkin S, Whooley M. (2005). Depression and medication adherence in outpatients with coronary heart disease: findings from the Heart and Soul Study. 165:2508–13.

Kluge HHP, Wickramasinghe K, Rippin HL et al. (2020). Prevention and control of non-communicable diseases in the COVID-19 response. Lancet. 395:1678–80.

Long, Q.; Li, J.; Hu, X.; Bai, Y.; Zheng, Y.; Gao, Z. (2021). Follow-Ups on Persistent Symptoms and Pulmonary Function Among Post-Acute COVID-19 Patients: A Systematic Review and Meta-Analysis. 8, 702635.

Huang, C.; Huang, L.; Wang, Y.; Li, X.; Ren, L.; Gu, X.; Kang, L.; Guo, L.; Liu, M.; Zhou, X.; et al. (2021). 6-month consequences of COVID-19 in patients discharged from hospital: A cohort study., 397, 220–232

Tavazzi G, Pellegrini C, Maurelli M, Belliato M, Sciutti F, Bottazzi A, et al. (2020). Myocardial localization of coronavirus in COVID-19 cardiogenic shock. 22:911–5.

Xiong TY, Redwood S, Prendergast B, Chen M. (2020). Coronaviruses and the cardiovascular system: Acute and long-term implications. 41:1798–800.

Inciardi RM, Lupi L, Zaccone G, Italia L, Raffo M, Tomasoni D, et al. (2020). Cardiac involvement in a patient with coronavirus disease 2019 (COVID-19) JAMA Cardiol.

American College of Cardiology. (2020). HFSA/ACC/AHA Statement Addresses Concerns Re: Using RAAS Antagonists in COVID-19.

Bertagnin E, Greco A, Bottaro G et al. (2021). Remote monitoring for heart failure management during COVID-19 pandemic. 32:100724.

Radin, J.M.; Quer, G.; Ramos, E.; Baca-Motes, K.; Gadaleta, M.; Topol, E.J.; Steinhubl, S.R. (2021). Assessment of Prolonged Physiological and Behavioral Changes Associated With COVID-19 Infection., e2115959.

Puntmann, V.O.; Carerj, M.L.; Wieters, I.; Fahim, M.; Arendt, C.; Hoffmann, J.; Shchendrygina, A.; Escher, F.; Vasa-Nicotera, M.; Zeiher, A.M.; et al. (2020) Outcomes of Cardiovascular Magnetic Resonance Imaging in Patients Recently Recovered from Coronavirus Disease 2019 (COVID-19), 5, 1265–1273.

D'Errico, S.; Zanon, M.; Montanaro, M.; Radaelli, D.; Sessa, F.; Di Mizio, G.; Montana, A.; Corrao, S.; Salerno, M.; Pomara, C. (2020). More than pneumonia: Distinctive features of sars-cov-2 infection. From autopsy findings to clinical implications: A systematic review. Microorganisms, 8, 1642.

Shi, S.; Qin, M.; Cai, Y.; Liu, T.; Shen, B.; Yang, F.; Cao, S.; Liu, X.; Xiang, Y.; Zhao, Q.; et al. (2020). Characteristics and clinical significance of myocardial injury in patients with severe coronavirus disease 2019., 41, 2070–2079

Piazza, G.; Campia, U.; Hurwitz, S.; Snyder, J.E.; Rizzo, S.M.; Pfeferman, M.B.; Morrison, R.B.; Leiva, O.; Fanikos, J.; Nauffal, V.; et al. (2020). Registry of arterial and venous thromboembolic complications in patients with Covid-19. 76, 2060–2072

Korkmaz, B.; Lesner, A.; Marchand-Adam, S.; Moss, C.; Jenne, D.E. (2020). Lung protection by cathepsin c inhibition: A new hope for Covid-19 and ards63, 13258–13265

Sakr, Y.; Giovini, M.; Leone, M.; Pizzilli, G.; Kortgen, A.; Bauer, M.; Tonetti, T.; Duclos, G.; Zieleskiewicz, L.; Buschbeck, S.; et al. (2020). Pulmonary embolism in patients with coronavirus disease-2019 (Covid-19) pneumonia: A narrative review., 10, 124.

Sidarta-Oliveira, D.; Jara, C.P.; Ferruzzi, A.J.; Skaf, M.S.; Velander, W.H.; Araujo, E.P.; Velloso, L.A. (2020). Sars-cov-2 receptor is co-expressed with elements of the kinin-kallikrein, renin-angiotensin and coagulation systems in alveolar cells. Sci., 10, 19522.

Grosse, C.; Grosse, A.; Salzer, H.J.F.; Dunser, M.W.; Motz, R.; Langer, R. (2020). Analysis of cardiopulmonary findings in Covid-19 fatalities: High incidence of pulmonary artery thrombi and acute suppurative bronchopneumonia., 49, 107263.

Lorkiewicz, P.; Waszkiewicz, N. (2021). Biomarkers of Post-COVID Depression. 10, 4142.

Serrano-Castro, P.J.; Estivill-Torrus, G.; Cabezudo-Garcia, P.; Reyes-Bueno, J.A.; Ciano Petersen, N.; Aguilar-Castillo, M.J.; Suarez-Perez, J.; Jimenez-Hernandez, M.D.; Moya-Molina, M.A.; Oliver-Martos, B.; et al. (2020). Impact of SARS-CoV-2 infection on neurodegenerative and neuropsychiatric diseases: A delayed pandemic? Neurologia, 35, 245–251.

Nersesjan, V.; Amiri, M.; Lebech, A.M.; Roed, C.; Mens, H.; Russell, L.; Fonsmark, L.; Berntsen, M.; Sigurdsson, S.T.; Carlsen, J.; et al. (2021). Central and peripheral nervous system complications of COVID-19: A prospective tertiary center cohort with 3-month follow-up., 268, 3086–3104

Wijeratne, T.; Crewther, S. (2020). Post-COVID 19 Neurological Syndrome (PCNS); a novel syndrome with challenges for the global neurology community., 419, 117179.

Renaud-Charest, O.; Lui, L.M.W.; Eskander, S.; Ceban, F.; Ho, R.; Di Vincenzo, J.D.; Rosenblat, J.D.; Lee, Y.;(2021). Subramaniapillai, M.; McIntyre, R.S. Onset and frequency of depression in post-COVID-19 syndrome: A systematic review. J. Psychiatr., 144, 129–137.

Bo, H.X.; Li, W.; Yang, Y.; Wang, Y.; Zhang, Q.; Cheung, T.; Wu, X.; Xiang, Y.T. **(2021).** Posttraumatic stress symptoms and attitude toward crisis mental health services among clinically stable patients with COVID-19 in China. 51, 1052–1053.

Raciti, L.; Calabro, R.S. (2021). Neurological complications of COVID-19: From pathophysiology to rehabilitation. An overview. 92, e2021317.