

Review Article

Post-COVID Syndrome

Michael Hallek, Kristina Adorjan, Uta Behrends,
Georg Ertl, Norbert Suttrop, Clara Lehmann, on behalf of the Long COVID Working Group
of the Scientific Advisory Board within the German Medical Association

Department I of Internal Medicine, Center of Integrated Oncology ABCD, University Hospital of Cologne and German Medical Association, Berlin: Prof. Dr. med. Michael Hallek

Department of Psychiatry and Psychotherapy, LMU University Hospital, Munich: PD Dr. med. Kristina Adorjan

Munich Chronic Fatigue Center for Young People, Children's Hospital, School of Medicine, Technical University Munich: Prof. Dr. med. Uta Behrends

German Society of Internal Medicine e.V. and Comprehensive Heart Failure Center, Würzburg: Prof. Dr. med. Georg Ertl

Medical Department of Infectious Diseases and Respiratory Medicine CCM/CVK/CBF, Charité-Universitätsmedizin Berlin: Prof. Dr. med. Norbert Suttrop

Department I of Internal Medicine, Division of Infectious Diseases, Faculty of Medicine and University Hospital Cologne, University of Cologne: Prof. Dr. med. Clara Lehmann

Summary

Background: As defined by the WHO, the term post-COVID syndrome (PCS) embraces a group of symptoms that can occur following the acute phase of a SARS-CoV-2 infection and as a consequence thereof. PCS is found mainly in adults, less frequently in children and adolescents. It can develop both in patients who initially had only mild symptoms or none at all and in those who had a severe course of coronavirus disease 2019 (COVID-19).

Methods: The data presented here were derived from a systematic literature review.

Results: PCS occurs in up to 15% of unvaccinated adults infected with SARS-CoV-2. The prevalence has decreased in the most recent phase of the pandemic and is lower after vaccination. The pathogenesis of PCS has not yet been fully elucidated. Virus-triggered inflammation, autoimmunity, endothelial damage (to blood vessels), and persistence of virus are thought to be causative. Owing to the broad viral tropism, different organs are involved and the symptoms vary. To date, there are hardly any evidence-based recommendations for definitive diagnosis of PCS or its treatment.

Conclusion: The gaps in our knowledge mean that better documentation of the prevalence of PCS is necessary to compile the data on which early detection, diagnosis, and treatment can be based. To ensure the best possible care of patients with PCS, regional PCS centers and networks embracing existing structures from all healthcare system sectors and providers should be set up and structured diagnosis and treatment algorithms should be established. Given the sometimes serious consequences of PCS for those affected, it seems advisable to keep the number of SARS-CoV-2 infections low by protective measures tailored to the prevailing pandemic situation.

Cite this as

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While the vast majority of patients recover from acute infection with SARS-CoV-2 without discernible sequelae, a proportion of patients experience long-term effects that can last for months (1–4, e1). The World Health Organization (WHO) estimates that following the acute phase of infection, 10–20% of SARS-CoV-2-infected individuals complain of persisting or new-onset symptoms in the longer course, which is referred to as post-COVID syndrome (PCS) (e2). PCS affects patients that were asymptomatic or had only mild acute symptoms and who self-isolated at home as well as patients with moderate or severe disease that required

hospitalization or care on an intensive care unit. The lack of control group in the numerous studies carries the risk of overestimating the prevalence of PCS (5, e45), since comparable symptoms potentially occurring in a control group are not included in the calculation. In principle, long-term sequelae can develop independently of severity and with or without demonstrable organ pathology. In the case of acute disease requiring intensive care, it may be difficult to differentiate PCS from post-intensive care syndrome (PICS), since the latter can be associated with similar clinical symptoms.

Methods

For the statement (6) on which this review article is based, the literature for the publishing period 2020–2022 was collated and reviewed in a structured, methodological review process (for a detailed description of the literature search, see *eMethods, eTables 1–4*). Searches were carried out between 19 July 2022 and 22 July 2022. The recommendations are based on these studies.

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Definition

The terminology and definition of long-COVID and PCS is not standardized. The term “long-COVID” emerged as a hashtag on social media during the early phase of the pandemic and is still used there by the majority of people (7, e3). Since the term PCS has become established in the specialist literature, including the S1 guideline of the the Association of the Scientific Medical Societies in Germany (*Arbeitsgemeinschaft der Wissenschaftlichen Medizinischen Fachgesellschaften*, AWMF) (8), it will be used in the following. The WHO has developed the following definition of PCS by a Delphi consensus (9): The symptoms must still be present more than 12 weeks after acute infection and persist for at least 2 months. There can be no other etiological explanation. The clinical course may be persistent, relapsing, or fluctuating (ICD-10 U09.9).

Protracted symptoms in the second and third month following SARS-CoV-2 infection are classified as persistent symptomatic infection and delayed recovery, respectively. In such cases, the ICD-10 code U08.9 may indicate the need for healthcare in the context of COVID-19. The authors of this statement do not consider the exacerbation or aggravation of preexisting diseases as PCS in the narrower sense.

Causes

Although the pathogenesis of PCS is not yet fully understood, there is very good evidence to support diverse general as well as organ-specific causes, which will be presented below (10, 11, e4).

The many and diverse organ manifestations of SARS-CoV-2-related disorders are due, in part, to the broad tropism of the virus, which is defined by the distribution of the viral receptor. Cell entry of SARS-CoV-2 begins with its binding to the angiotensin-converting enzyme-2 (ACE2) receptor (12). The ACE2 receptor is abundantly present in tissues in the human body. It has been demonstrated in the lungs, kidneys, small intestine, olfactory neuroepithelium, heart, testes, muscle cells, and substantia nigra in the brain (13, e5–e9). Accordingly, the number of organs in which the virus or viral components can be found is large. Infection typically begins on the mucous membranes of the mouth, nose, and lungs and can spread in the further course. The presence of ACE2 receptors in the vascular endothelium as well as the development of accompanying inflammatory and immunological processes provide a first possible explanation for the great diversity in the clinical manifestations of COVID-19 (e9).

Endothelial dysfunction

SARS-CoV-2 infection can cause vascular inflammation (11) that leads to impaired microcirculation and endothelial dysfunction (ED) (14). A third of patients with PCS exhibit ED in endothelial dysfunction testing (EndoPAT) as well as elevated levels of the potent vasoconstrictor endothelin-1 (ET-1) 6 months following mild COVID-19 (e10). ED can also cause changes

to the retina (e11) and affect reproductive health (e12), for example, through new-onset erectile dysfunction (e13).

Viral persistence

A number of studies show that residual SARS-CoV-2 can persist for more than 6 months after the acute phase of COVID-19 (11), despite the fact that viral replication can no longer be demonstrated. One study showed a persistent spike 1 (S1) protein in CD16 + monocytes of patients with PCS (e14). The gut can be a reservoir for viral persistence—a link to PCS has not been investigated (15, e15). It is possible that persistent viral components cause ongoing inflammation that could ultimately lead to PCS.

Autoimmunity

Autoantibodies (AAB) are detectable not only during acute infection but also in PCS (16). For example, AAB against type-1 interferons as well as G-protein-coupled receptors (GPCR) that have an effect on the control of the autonomic nervous system (e16) have been detected in PCS patients (e16). Antineuronal AAB have been found in the cerebrospinal fluid of patients with neurological manifestations of PCS (e17). It was shown in a large collective that the detection of antinuclear antibodies (ANAs), interferon-alpha AAB, and proinflammatory cytokines in the acute phase correlated with the development of gastrointestinal or respiratory symptoms in the setting of PCS (e18).

Persistent inflammation

Persistent inflammation is an established pathomechanism in PCS (e19), even when SARS-CoV-2 infection and replication can no longer be detected. As long as 8 months following infection, PCS patients still show immunological abnormalities, characterized by an inflammatory cytokine signature, compared to non-infected individuals or patients infected with other viruses. In particular, persistent inflammation was observed in the lungs, heart, and central nervous system (17, e20, e21). A major aspect of persistent inflammation is the defective repair of the sequelae of inflammation (e22). In studies, this inflammatory cytokine signature has a positive predictive value of 79–82% for the development of long-term symptoms such as fatigue, dyspnea, or chest pain, and includes, for example, type I and type III interferons (18). PCS patients also exhibit altered activation patterns of monocytes, granulocytes, and dendritic cells (e21).

Psychosocial factors

In addition to the direct biological sequelae of SARS-CoV-2 infection consistent with a postviral syndrome, one must also consider psychosocial factors, which could either be, for example, the manifestation of separate mental illnesses or the result of measures taken to contain the pandemic. Not only the stressors associated with the effects of COVID-19 infection but also the measures taken against the pandemic can lead many

BOX

Risk factors for post-COVID syndrome (2, 24, 33–36, e41–e44)

- **Biographical factors**
 - Caucasian population
 - Middle age
 - Female sex
- **Preexisting diseases**
 - Bronchial asthma
 - Poor mental health
 - Diabetes mellitus
 - Hypertension
 - Obesity
- **COVID-19-specific**
 - Multiple (> 5) acute symptoms
 - High acute viral load
 - Low baseline SARS-CoV-2 IgG
 - Diarrhea
 - Vaccination status

(From [6]: reprinted with kind permission from the German Medical Association [Bundesärztekammer])

people to develop new-onset mental illness or experience a worsening of existing mental health disorders (19). These stressors may be due to the situation arising from quarantine, loneliness, home office, home schooling, uncertainty about how the pandemic will evolve, threat to economic livelihood, or concern about relatives. This worsening is clearly linked not only to a reduction in the quality of medical care but also to unfavorable health-related behavior, for example, lower levels of physical activity, longer times spent in bed, and increased rumination. Negative effects of the pandemic and the measures for its containment have also been described for other mental illnesses, for example anxiety disorders and eating disorders, as well as for psychosocial stressors such as domestic violence and family conflicts. They result in greater utilization of mental health services (e23, e24). These associations are similar for children and adolescents.

Predisposing factors, risk factors, and protection through vaccination

The currently known risk factors for the development of PCS are summarized in the *Box*.

SARS-CoV-2 vaccination appears to significantly reduce the risk of PCS (20–22). Overall, the presence of vaccination was associated with a lower risk or lower likelihood of PCS. Two vaccine doses appear to be more effective than one (20). Figures from the United Kingdom’s COVID Surveillance Study (as of 27.05.2022) (e25) show that triple vaccination can reduce the prevalence of PCS to below 5% (23).

Individual susceptibility in adults for the development of PCS appears to be independent of the severity of the acute pulmonary and systemic disease (e26, e27).

Incidence

The variety and frequency of symptoms that can develop following the acute phase of SARS-CoV-2 infection are not always directly comparable across the various studies, given that the investigated cohorts differ in terms of size, selection process, and symptom recording. In addition, studies without control groups harbor the risk of overestimating PCS. In 10 UK longitudinal studies, the percentage of individuals presumed to have COVID-19 that reported long-term symptoms after more than 12 weeks was between 7.8 and 17% (with a total of 1.2–4.8% reporting debilitating symptoms) (24).

Assuming that approximately 5–15% of adult unvaccinated patients develop PCS, a relatively large number of individuals would be affected by PCS. With 22 million individuals having recovered from COVID-19 (as of August 2022), one can assume that statistically, the number of people with PCS in Germany would be several hundred thousand. One needs to bear in mind that this process is subject to dynamic changes that depend in particular on virus variants and the level of immunization in the population.

Symptoms, diagnosis, and treatment

Since the ACE2 receptor is expressed in many organs and COVID-19 manifests in multiple organs, PCS can also present with diverse clinical symptoms and organ manifestations (e21, e28) (*Table*). As a general rule, the main symptoms occurring in adults can also be observed in children and adolescents, albeit far more rarely (25). The course of the pandemic thus far has shown that symptoms and organ manifestations can change depending on the prevailing SARS-CoV-2 virus variant and the vaccination status of those infected (20–23).

Since no specific diagnostic markers (for example, in blood) or characteristic imaging findings are known to date, the diagnosis of PCS needs to be made on the basis of clinical presentation. This can be particularly challenging in children and adolescents due to the limited self-reported patient history. A prerequisite of establishing the diagnosis of PCS is that the relevant symptoms were not already present prior to SARS-CoV-2 infection and that patients experience impairments in everyday life as well as a level of suffering, meaning that previous medical findings as well as the collaboration of the various healthcare providers take on central importance (*Figure*). Patients suffering from fatigue and exercise intolerance need to be assessed for myalgic encephalomyelitis/chronic fatigue syndrome (ME/CFS) on the basis of clinical diagnostic scores. Differentiation from depression is a common differential diagnostic question due to the 1-year incidence of depression of approximately 8% in the adult population.

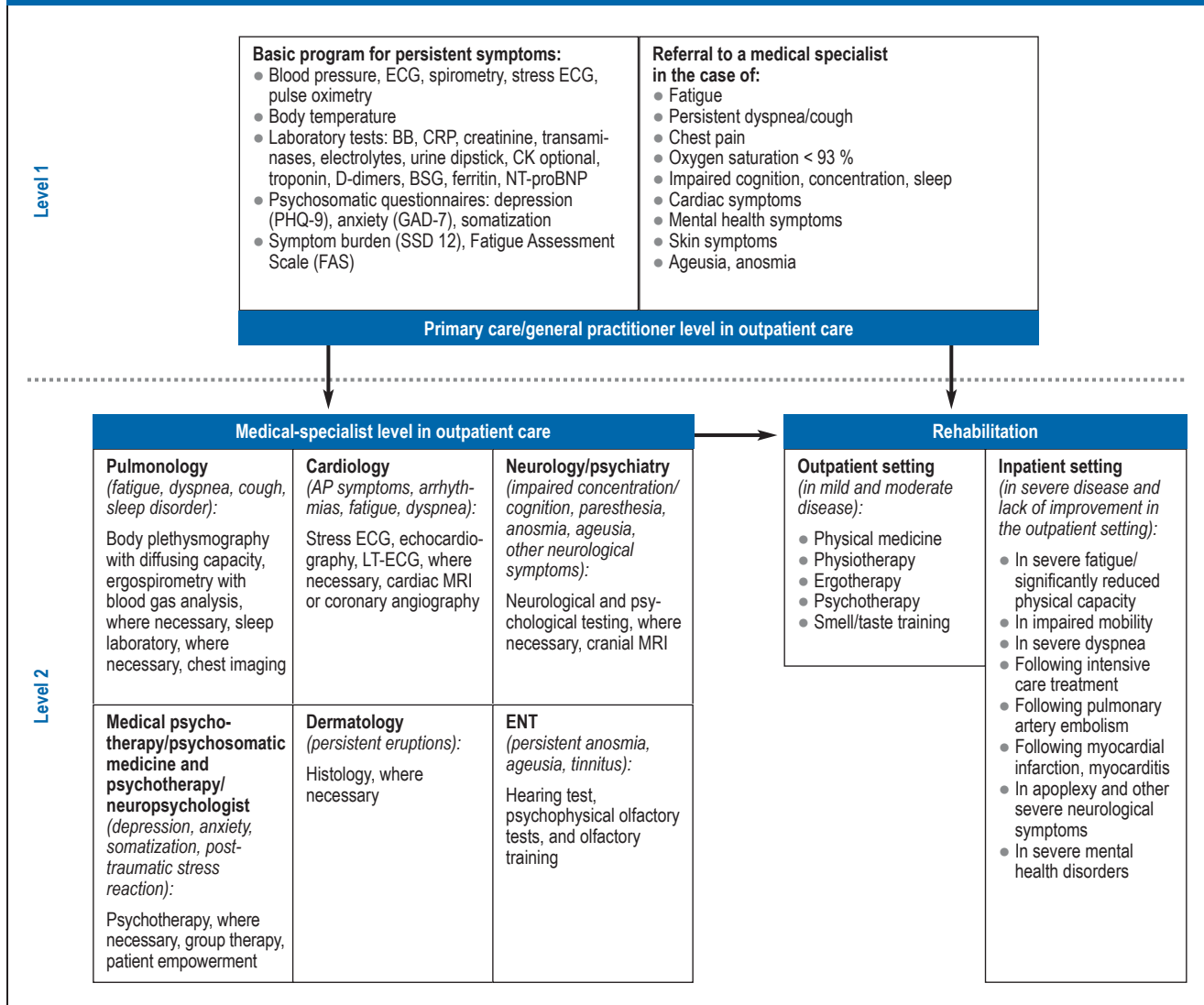
TABLE

Organ-related disorders with a morphological substrate in PCS

Organ	Clinical symptoms	Morphological manifestation and findings		Pathophysiological mechanisms
		Imaging	Histology, immunohistology, molecular pathology	
Olfactory/gustatory system see also "CNS and PNS"	Loss of or reduction in sense of taste and smell (dysgeusia, anosmia)	CT and MRI: diffusely increased signal intensity in the olfactory bulb, hyperintense foci or microhemorrhages, clumping and thinning of olfactory filia (e46)	Leukocyte infiltration of the lamina propria with apoptotic damage to taste buds, olfactory nerve fibers, and central nervous olfactory center Autopsy: focal atrophy of the olfactory epithelium (37)	ACE2 receptors in the CNS (olfactory bulb, amygdala, hippocampus, temporal lobe, posterior cingulate cortex, brainstem)
Lungs, upper airways	Dyspnea, persistent cough, asthma exacerbation (38)	CT: persistent changes, e.g., ground glass opacity, interstitial thickening, peripheral reticulation, fibrosis, bronchiectasis (e1)	Usual interstitial pneumonia (UIP), diffuse alveolar fibrosis and scarring, organizing pneumonia (e47), endotheliitis, microhemorrhages (e48), IHC detection of ACE2 ⁺ in the lungs (especially type-II pneumocytes and alveolar macrophages) (e49)	Persistent SARS-CoV-2 RNA in lung tissue (virus reservoir) with overactivation of alveolar epithelial cells (ACE2 ⁺) and reduction in alveolar macrophages, development of chronic scarring inflammation (e21); detection of profibrotic macrophage responses (e50, e51)
Heart/myocardium	Atypical chest pain, sensation of pressure in the chest, tachycardia, palpitation (38, 39), lung congestion, arrhythmias, pericardial friction rub	cMRI: COVID-19-related myocardial inflammation (e51)	Endomyocardial biopsies: active lymphocytic inflammation (e51), thrombi in small and larger heart vessels (39, e48), IHC detection of ACE2 ⁺ in monocytes (e49)	Persistent viral load induced in ACE2 ⁺ myocytes and myocardial inflammation with pro-inflammatory cells, infiltrating monocytes, neutrophils, and plasmacytoid dendritic cells (e21)
Brain (CNS) and peripheral nervous system (PNS) see also "Olfactory/gustatory system"	Sleepiness, fatigue, brain fog, headache, impaired memory/concentration, diverse psychiatric alterations, numbness, tremor	18F-FDG PET-based neuroimaging: hypometabolic CNS regions (olfactory gyrus, temporal lobe, including amygdala, hippocampus, hypothalamus, brainstem, cerebellum) (e52)	Viral neuroinvasion, neuroimmunological response in the peripheral and central nervous system with disrupted blood-brain barrier; detection at autopsy of ACE2 in brainstem cells	Hypothesis: neurotropic SARS-CoV-2 (infects neuronal cell cultures and organoids) affects ACE2 ⁺ cells (neurons, astrocytes) and brainstem cells (e53)
Skeletal muscle	Muscle weakness, myalgia, arthritis in small joints (38, e54)		Diffuse inflammatory infiltration of muscles, connective tissue, and joints	see cardiac muscle
Kidneys	Reduced glomerular filtration rate, microhematuria		Thrombosis of small renal vessels, especially in glomeruli; IHC: ACE2 ⁺ in the brush border and cytoplasm of the proximal tubular cells (e49)	Persistent SARS-CoV-2 RNA in renal vessels and ACE2 ⁺ tubular epithelial cells inducing chronic cell damage
Vessels	Phlebitis and thrombophlebitis		Inflammatory vessel wall infiltration of the endothelium of small-to-large arteries and sporadically in smooth muscle cells (e51)	Persistent viral invasion of endothelial cells with inflammation-related alternations as the basis of thrombus formation: often persistent hypercoagulability
Gastrointestinal tract	Nausea, diarrhea, loss of appetite, abdominal pain (40)	Abdominal radiological investigations are not specific for COVID-19-induced symptoms	IHC detection of ACE2 ⁺ enterocytes, especially in absorptive enterocytes in the ileum with signs of chronic inflammation (e21)	Viral persistence in ACE2-expressing gastrointestinal cells with subsequent chronic cell damage (e55)
Reproductive system	Erectile dysfunction		Endothelial damage	Endothelial cell injury (e13); pituitary-gonadal axis with reduced testosterone (e56)
Islet cell apparatus of the pancreas	Diabetes		IHC detection of ACE2 in pancreatic islet cells (e57)	Viral persistence in ACE2-expressing islet cells with loss of function

ACE2, angiotensin-converting enzyme 2; cMRI, cardiovascular magnetic resonance imaging; CT, computed tomography; IHC, immunohistochemistry; MRI, magnetic resonance imaging; PNS, peripheral nervous system; PET, positron emission tomography; US, ultrasound; 18F-FDG, 18F-fluorodeoxyglucose; CNS, central nervous system

FIGURE 1



Collaboration between the different care providers

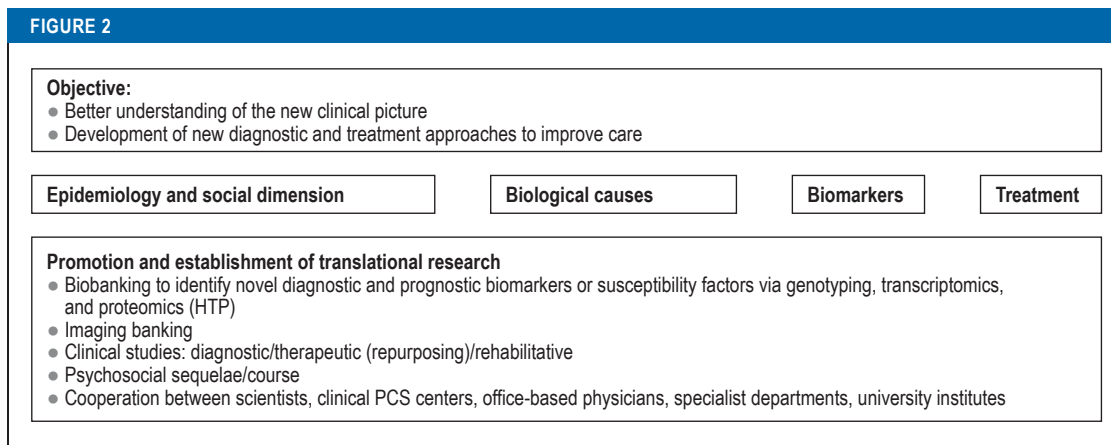
AP, angina pectoris; BB, glycogen phosphorylase; ESR, erythrocyte sedimentation rate; CK, creatine kinase; CRP, C-reactive protein; LT-ECG, long-term electrocardiography; MRI, magnetic resonance imaging; NT-proBNP, N-terminal pro-brain natriuretic peptide; TSH, thyroid stimulating hormone; (from [6]: reprinted with kind permission from the German Medical Association [Bundesärztekammer])

A targeted assessment of findings, paying particular attention to new-onset symptom-related limitations, and the basic laboratory work-up are of crucial importance (8), since in many cases PCS represents a diagnosis of exclusion. The S1 guideline of the AWMF provides an overview of the individual organ manifestations and the initial assessment in suspected PCS (8). It is important to accurately record the various symptoms in order to offer patients tailored treatment and rehabilitation concepts aimed at shortening the recovery phase.

There are currently no evidence-based, causal, specific treatment options. Only scant interventional studies are available, and no therapeutic concept has been sufficiently validated to date (26). Therefore, no reliable recommendations can be made for numerous

procedures, such as apheresis, vitamin replacement, and other pharmacological interventions. Current treatment concepts are based on an interdisciplinary, pragmatic approach that includes physical rehabilitation measures as well as symptom-oriented treatment of the various organ disorders. There are meta-analyses of randomized controlled studies on the efficacy and effectiveness of physical procedures in PCS that support symptom-oriented physical rehabilitation measures (26–30, e29). In the case of ME/CFS, all diagnostic and therapeutic measures need to be tailored to the often significantly limited physical capacity of individual patients. Pacing, that is to say, sparing, dosed management of the patient's energy resources and strict avoidance of overexertion, is recommended.

FIGURE 2



Understanding post-COVID syndrome—dimensions of scientific analysis (from [6]: reprinted with kind permission from the German Medical Association [*Bundesärztekammer*])

Thus, it remains essential that targeted treatment approaches be identified in the future. Further studies are required on, for example, the effectiveness of vaccinations or the administration of antibodies against SARS-CoV-2 in PCS (e30). Initial results indicate a lasting improvement in PCS following a second vaccine dose, at least in the median follow-up period of 67 days (31).

Likewise in children and adolescents, treatment has thus far been symptom-oriented (32). In the case of interdisciplinary and, where appropriate, multimodal treatment, somatic and mental health aspects need to be taken into account, and physical capacity must be considered on a case-by-case basis.

Current structures and potential needs regarding PCS treatment and research

The sociomedical and economic impact of PCS cannot be foreseen but is likely to be immense. Since PCS is a multisystem disease, an interdisciplinary (including infectious diseases, internal medicine, neurology, psychiatry and psychotherapy, psychosomatics, pulmonology, cardiology, rheumatology, ENT, physical medicine and rehabilitation, general medicine, pain medicine, pediatrics) and intersectoral collaboration involving cooperation with general practitioners and specialists in pediatric and adolescent medicine seems imperative for the comprehensive care of these patients. Close cooperation is needed between primary care and specialist outpatient healthcare providers and centers in larger hospitals.

Against this backdrop, the following structures are required: For clinical care, specialized PCS centers need to be set up at maximum-care institutions (generally university hospitals), where specialists from a number of disciplines can provide comprehensive care (Figure 2). Structures of this kind already exist at some university hospitals in Germany (e31–e37). These PCS centers should form regional PCS networks with local hospitals and practices or embrace existing networks in order to ensure the provision of

care to the large number of primarily adult patients (e38, e39).

In addition to providing interdisciplinary care, the PCS centers should also collaborate on translational research efforts. The main focus will be to evaluate the concepts of the newly created care structures, to investigate the effects of more interdisciplinary treatment strategies on the course of the disease, and to develop diagnostic guidelines and novel treatments for PCS. Furthermore, the formation of a national PCS network that coordinates the collaboration of all important actors and is also the contact point for both science and policy is proposed.

For housebound or bedridden PCS sufferers, there is an urgent need to strengthen and expand telemedical and outreach care structures (for example, specialized outpatient palliative care [SOPC]).

In addition to providing interdisciplinary care, the PCS centers should collaborate on translational research with the aim of developing scientifically based diagnostic guidelines and novel PCS treatments as rapidly as possible.

The primary focus of this research should be a patient-oriented treatment approach (Figure 2) that will advance translational concepts at an internationally competitive level and within an international network as early on as possible.

Other collaborators

Prof. Dr. med. Reinhard Berner, Prof. Dr. med. Dr. h. c. Manfred Dietel, Prof. Dr. med. Hans Drexler, Dr. med. Pedram Emami, Dr. med. Christiana Franke, Dr. med. Johannes Grundmann, Prof. Dr. med. Ulrich Hegerl, Prof. Dr. med. Karl Hörmann, Dr. med. Susanne Johna, Univ.-Prof. Dr. med. Florian Klein, Prof. Dr. med. Thea Koch, Prof. Dr. med. Wilhelm-Bernhard Niebling, Prof. Dr. med. Johannes Oldenburg, Prof. Dr. med. Klaus Püschel, Dr. med. Gerald Quitterer, Dr. med. (I) Klaus Reinhardt, Dr. med. Anett Reißhauer, Prof. Dr. med. Carmen Scheibenbogen, Prof. Dr. med. Stefan Schreiber, Dr. med. Martina Wenker, Prof. Dr. med. Fred Zepp

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Conflict of interest statement

PD Dr. Adorjan received funding from the Bavarian State Ministry of Health and Care (*Bayerisches Staatsministerium für Gesundheit und Pflege*) as well as the Bavarian State Office for Health and Food Safety (*Bayerisches Landesamt für Gesundheit und Lebensmittelsicherheit*).

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Prof. Hallek declares that no conflict of interest exists.

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References

1. Augustin M, Schommers P, Stecher M, et al.: Post-COVID syndrome in non-hospitalised patients with COVID-19: a longitudinal prospective cohort study. *Lancet Reg Health Eur* 2021; 6: 100122.
2. Sudre CH, Murray B, Varsavsky T, et al.: Attributes and predictors of long COVID. *Nat Med* 2021; 27: 626–31.
3. Nalbandian A, Sehgal K, Gupta A, et al.: Post-acute COVID-19 syndrome. *Nat Med* 2021; 27: 601–15.
4. Huang L, Yao Q, Gu X, et al.: 1-year outcomes in hospital survivors with COVID-19: a longitudinal cohort study. *The Lancet* 2021; 398(10302): 747–58.
5. Amin-Chowdhury Z, Ladhani SN: Causation or confounding: why controls are critical for characterizing long COVID. *Nat Med* 2021; 27: 1129–30.
6. Bundesärztekammer: Post-COVID-Syndrom (PCS). *Deutsch Arztebl* DOI: 10.3238/arztebl.2022.Stellungnahme_PCS (last accessed on 4 January 2023).
7. Callard F, Perego E: How and why patients made Long Covid. *Soc Sci Med* 2021; 268: 113426.
8. AWMF online—Das Portal der wissenschaftlichen Medizin: S1-Leitlinie Post-COVID/Long-COVID. www.awmf.org/uploads/tx_szleitlinien/020-0271_S1_Post_COVID_Long_COVID_2021-07.pdf (last accessed on 21 June 2022).
9. World Health Organization: A clinical case definition of post COVID-19 condition by a Delphi consensus. www.who.int/publications/i/item/WHO-2019-nCoV-Post_COVID-19_condition-Clinical_case_definition-2021.1 (last accessed on 22 June 2022).
10. Ackermann M, Verleden SE, Kuehnel M, et al.: Pulmonary vascular endothelialitis, thrombosis, and angiogenesis in Covid-19. *N Engl J Med* 2020; 383: 120–8.
11. Castanares-Zapatero D, Chalou P, Kohn L, et al.: Pathophysiology and mechanism of long COVID: a comprehensive review. *Ann Med* 2022; 54: 1473–87.

12. Hoffmann M, Kleine-Weber H, Schroeder S, et al.: SARS-CoV-2 cell entry depends on ACE2 and TMPRSS2 and is blocked by a clinically proven protease inhibitor. *Cell* 2020; 181: 271–280.e8.
13. Ziegler CGK, Allon SJ, Nyquist SK, et al.: SARS-CoV-2 receptor ACE2 is an interferon-stimulated gene in human airway epithelial cells and is detected in specific cell subsets across tissues. *Cell* 2020; 181: 1016–1035.e19.
14. Charfeddine S, Ibn Hadj Amor H, Jdidi J, et al.: Long COVID 19 syndrome: is it related to microcirculation and endothelial dysfunction? Insights from TUN-EndCOV Study. *Front Cardiovasc Med* 2021; 8: 745758.
15. Gaebler C, Wang Z, Lorenzi JCC, et al.: Evolution of antibody immunity to SARS-CoV-2. *Nature* 2021; 591: 639–44.
16. Wang EY, Mao T, Klein J, et al.: Diverse functional autoantibodies in patients with COVID-19. *Nature* 2021; 595: 283–8.
17. Puntmann VO, Martin S, Shchendrygina A, et al.: Long-term cardiac pathology in individuals with mild initial COVID-19 illness. *Nat Med* 2022; 28: 2117–23.
18. Phetsouphanh C, Darley DR, Wilson DB, et al.: Immunological dysfunction persists for 8 months following initial mild-to-moderate SARS-CoV-2 infection. *Nat Immunol* 2022; 23: 210–6.
19. Czaplicki A, Reich H, Hegerl U: Lockdown measures against the spread of the COVID-19 pandemic: negative effects for people living with depression. *Front Psychol* 2022; 13: 789173.
20. Oyungerel B, Paulina S, Justin C, Kylie A, Paul G: Impact of COVID-19 vaccination on long COVID: a systematic review and meta-analysis. *Medrxiv* 2022.
21. Notarte KI, Catahay JA, Velasco JV, et al.: Impact of COVID-19 vaccination on the risk of developing long-COVID and on existing long-COVID symptoms: a systematic review. *EClinicalMedicine* 2022; 53: 101624.
22. Al-Aly Z, Bowe B, Xie Y: Long COVID after breakthrough SARS-CoV-2 infection. *Nat Med* 2022; 28: 1461–7.
23. Ayoubkhani D, Bosworth M: Self-reported long COVID after infection with the Omicron variant in the UK: 18 July 2022: The likelihood of self-reported long COVID after a first coronavirus (COVID-19) infection compatible with the Omicron BA.1 or BA.2 variants, compared with the Delta variant, using data from the COVID-19 Infection Survey. www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/bulletins/self-reported-long-covid-after-infection-with-the-omicron-variant/18july2022#toc (last accessed on 26 August 2022).
24. Thompson EJ, Williams DM, Walker AJ, et al.: Long COVID burden and risk factors in 10 UK longitudinal studies and electronic health records. *Nat Commun* 2022; 13: 3528.
25. Borch L, Holm M, Knudsen M, Ellermann-Eriksen S, Hagstroem S: Long COVID symptoms and duration in SARS-CoV-2 positive children—a nationwide cohort study. *Eur J Pediatr* 2022; 181: 1597–607.
26. Hawke LD, Nguyen ATP, Ski CF, Thompson DR, Ma C, Castle D: Interventions for mental health, cognition, and psychological well-being in long COVID: a systematic review of registered trials. *Psychol Med* 2022: 1–15.
27. Fugazzaro S, Contri A, Esseroukh O, et al.: Rehabilitation interventions for post-acute COVID-19 syndrome: a systematic review. *Int J Environ Res Public Health* 2022; 19: 5185.
28. Halabchi F, Selk-Ghaffari M, Tazesh B, Mahdavi B: The effect of exercise rehabilitation on COVID-19 outcomes: a systematic review of observational and intervention studies. *Sport Sci Health* 2022: 1–19.
29. Chandan JS, Brown K, Simms-Williams N, et al.: Non-pharmacological therapies for postviral syndromes, including Long COVID: a systematic review and meta-analysis protocol. *BMJ Open* 2022; 12: e057885.
30. Vieira A, Pinto A, Garcia B, Eid RAC, Mol CG, Nawa RK: Telerehabilitation improves physical function and reduces dyspnoea in people with COVID-19 and post-COVID-19 conditions: a systematic review. *J Physiother* 2022; 68: 90–8.
31. Ayoubkhani D, Bermingham C, Pouwels KB, et al.: Trajectory of long covid symptoms after covid-19 vaccination: community based cohort study. *BMJ* 2022; 377: e069676.
32. DGKJ-Konvent-Gesellschaften mA: Einheitliche Basisversorgung von Kindern und Jugendlichen mit Long COVID. <https://link.springer.com/>

- content/pdf/10.1007/s00112-021-01408-1.pdf (last accessed on 22 June 2022).
33. Antonelli M, Pujol JC, Spector TD, Ourselin S, Steves CJ: Risk of long COVID associated with delta versus omicron variants of SARS-CoV-2. *Lancet* 2022; 399: 2263–4.
 34. Antonelli M, Penfold RS, Merino J, et al.: Risk factors and disease profile of post-vaccination SARS-CoV-2 infection in UK users of the COVID Symptom Study app: a prospective, community-based, nested, case-control study. *Lancet Infect Dis* 2022; 22: 43–55.
 35. Crook H, Raza S, Nowell J, Young M, Edison P: Long covid-mechanisms, risk factors, and management. *BMJ* 2021; 374: n1648.
 36. Yong SJ: Long COVID or post-COVID-19 syndrome: putative pathophysiology, risk factors, and treatments. *Infect Dis (Lond)* 2021; 53: 737–54.
 37. Yong SJ: Persistent brainstem dysfunction in Long-COVID: a hypothesis. *ACS Chem Neurosci* 2021; 12: 573–80.
 38. Carfi A, Bernabei R, Landi F: Persistent symptoms in patients after acute COVID-19. *JAMA* 2020; 324: 603–5.
 39. Dennis A, Wamil M, Alberts J, et al.: Multiorgan impairment in low-risk individuals with post-COVID-19 syndrome: a prospective, community-based study. *BMJ Open* 2021; 11: e048391.
 40. Weng J, Li Y, Li J, et al.: Gastrointestinal sequelae 90 days after discharge for COVID-19. *Lancet Gastroenterol Hepatol* 2021; 6: 344–6.

Corresponding author

Prof. Dr. med. Michael Hallek
 Bundesärztekammer
 Herbert-Lewin-Platz 1, 10623 Berlin, Germany
 dezernat6@baek.de

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► Supplementary material

eReferences, eMethods, eTables:
www.aerzteblatt-international.de/m2022.0409

CLINICAL SNAPSHOT



Status following right-sided placement of a tympanostomy tube Red arrow: indwelling tympanostomy tube

Initial Diagnosis of Acute Myeloid Leukemia Due to Sudden-Onset Bilateral Hearing Loss

A male patient presented due to sudden-onset bilateral hearing loss bordering on deafness, accompanied on the previous day by painless, atraumatic hemorrhage from the right auditory canal, which stopped spontaneously. No tinnitus or vertigo was reported by the patient. During microscopic examination of the ear, a dark-livid discoloration of both eardrums was apparent; the Valsalva maneuver was negative. Audiogram revealed a pre-existing presbycusis and a new-onset bilateral pantonal sound conduction component of up to 50 dB. The tympanogram was flat on both sides. Since hematotympanon was suspected, paracentesis was carried out bilaterally; in addition, tympanostomy tubes were inserted due to pronounced otorrhea (old blood). Postoperatively, the patient’s hearing immediately improved. As a result of the spontaneous hemorrhage of unknown cause, a laboratory investigation was performed in a first step. A differential blood count is a cost-effective and readily available pillar of diagnosis to rule out or

confirm the suspicion of malignant degeneration of myeloid or lymphoid leukocytes and—as in this case—is also of considerable prognostic value in cases of spontaneous bleeding. In addition to a general departure from reference values, the patient exhibited marked thrombocytopenia (~ 4000/μL), which is typical of acute myeloid leukemia (AML), and an Hb of 4.1 g/dL. Following the initiation of additional diagnostic tests (bone marrow biopsy, etc.) and a co-assessment by our colleagues in the hematology department, this initial diagnosis of AML prompted the initiation of guideline-based treatment.

Sina Marie Beisel, Prof. Dr. med. Burkard M. Lippert, Hals-Nasen-Ohrenklinik, Plastische Operationen, SLK-Kliniken Heilbronn GmbH, sinamaria.beisel@slk-kliniken.de

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Supplementary material to:

Post-COVID Syndrome

by Michael Hallek, Kristina Adorjan, Uta Behrends, Georg Ertl, Norbert Suttorp, and Clara Lehmann, on behalf of the Long COVID Working Group of the Scientific Advisory Board within the German Medical Association

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eReferences

e1. Huang C, Huang L, Wang Y, et al.: 6-month consequences of COVID-19 in patients discharged from hospital: a cohort study. *Lancet* 2021; 397: 220–32.

e2. Rajan S, Khunti K, Alwan N, et al.: In the wake of the pandemic: preparing for Long COVID. Copenhagen (Denmark): European Observatory on Health Systems and Policies 2021.

e3. Perego E, Balzarini F, Botteri M, et al.: Emergency treatment in Lombardy: a new methodology for the pre-hospital drugs management on advanced rescue vehicles. *Acta Biomed* 2020; 91: 111–8.

e4. Nauen DW, Hooper JE, Stewart CM, Solomon IH: Assessing brain capillaries in coronavirus disease 2019. *JAMA Neurol* 2021; 78: 760–2.

e5. Hamming I, Timens W, Bulthuis MLC, Lely AT, Navis GJ, van Goor H: Tissue distribution of ACE2 protein, the functional receptor for SARS coronavirus. A first step in understanding SARS pathogenesis. *J Pathol* 2004; 203: 631–7.

e6. Qi J, Zhou Y, Hua J, et al.: The scRNA-seq expression profiling of the receptor ACE2 and the cellular protease TMPRSS2 reveals human organs susceptible to SARS-CoV-2 infection. *Int J Environ Res Public Health* 2021; 18: 284.

e7. Chen M, Shen W, Rowan NR, et al.: Elevated ACE-2 expression in the olfactory neuroepithelium: implications for anosmia and upper respiratory SARS-CoV-2 entry and replication. *Eur Respir J* 2020; 56:2001948.

e8. Baig AM, Khaleeq A, Ali U, Syeda H: Evidence of the COVID-19 virus targeting the CNS: tissue distribution, host-virus interaction, and proposed neurotropic mechanisms. *ACS Chem Neurosci* 2020; 11: 995–8.

e9. Salamanna F, Maglio M, Landini MP, Fini M: Body localization of ACE-2: on the trail of the keyhole of SARS-CoV-2. *Front Med (Lausanne)* 2020; 7: 594495.

e10. Haffke M, Freitag H, Rudolf G, et al.: Endothelial dysfunction and altered endothelial biomarkers in patients with post-COVID-19 syndrome and chronic fatigue syndrome (ME/CFS). *J Transl Med* 2022; 20: 138.

e11. Hohberger B, Ganslmayer M, Lucio M, et al.: Retinal microcirculation as a correlate of a systemic capillary impairment after severe acute respiratory syndrome Coronavirus 2 Infection. *Front Med (Lausanne)* 2021; 8: 676554.

e12. Kresch E, Achua J, Saltzman R, et al.: COVID-19 endothelial dysfunction can cause erectile dysfunction: histopathological, immunohistochemical, and ultrastructural study of the human penis. *World J Mens Health* 2021; 39: 466–9.

e13. Chu KY, Nackeran S, Horodyski L, Masterson TA, Ramasamy R: COVID-19 infection is associated with new onset Erectile Dysfunction: insights from a national registry. *Sex Med* 2022; 10: 100478.

e14. Patterson BK, Francisco EB, Yogendra R, et al.: Persistence of SARS CoV-2 S1 protein in CD16+ monocytes in post-acute sequelae of COVID-19 (PASC) up to 15 months post-infection. *Front Immunol* 2021; 12: 746021.

e15. Zollner A, Koch R, Jukic A, et al.: Postacute COVID-19 is characterized by gut viral antigen persistence in inflammatory bowel diseases. *Gastroenterology* 2022; 2: 495–506.e8.

e16. Wallukat G, Hohberger B, Wenzel K, et al.: Functional autoantibodies against G-protein coupled receptors in patients with persistent Long-COVID-19 symptoms. *J Transl Autoimmun* 2021; 4: 100100.

e17. Franke C, Ferse C, Kreye J, et al.: High frequency of cerebrospinal fluid autoantibodies in COVID-19 patients with neurological symptoms. *Brain Behav Immun* 2021; 93: 415–9.

e18. Su Y, Yuan D, Chen DG, et al.: Multiple early factors anticipate post-acute COVID-19 sequelae. *Cell* 2022; 185: 881–895.e20.

e19. Pierce JD, Shen Q, Cintron SA, Hiebert JB: Post-COVID-19 syndrome. *Nurs Res* 2022; 71: 164–74.

e20. Meinhardt J, Radke J, Dittmayer C, et al.: Olfactory transmucosal SARS-CoV-2 invasion as a port of central nervous system entry in individuals with COVID-19. *Nat Neurosci* 2021; 24: 168–75.

e21. Mehandru S, Merad M: Pathological sequelae of long-haul COVID. *Nat Immunol* 2022; 23: 194–202.

e22. Melms JC, Biermann J, Huang H, et al.: A molecular single-cell lung atlas of lethal COVID-19. *Nature* 2021; 595: 114–9.

e23. Witte J, Zeitler A, Batram M, Diekmannshemke J, Hasemann L: Kinder- und Jugendreport 2022: Kinder- und Jugendgesundheit in Zeiten der Pandemie. Eine Studie im Auftrag der DAK Gesundheit. www.dak.de/dak/download/wissenschaftlicher-text-von-dr-witte-2572496.pdf (last accessed on 2 September 2022).

e24. Universitätsklinikum Hamburg-Eppendorf: COPSy-Längsschnittstudie. www.uke.de/kliniken-institute/kliniken/kinder-und-jugendpsychiatrie-psychotherapie-und-psychosomatik/forschung/arbeitsgruppen/child-public-health/forschung/copsy-studie.html (last accessed on 2 September 2022).

e25. Office for National Statistics (ONS) UK: Coronavirus (COVID-19) infection survey, UK 27 May 2022: percentage of people testing positive for coronavirus (COVID-19) in private residential households in England, Wales, Northern Ireland and Scotland, including regional and age breakdowns. [/www.ons.gov.uk/people-population-and-community/healthandsocialcare/conditionsanddis-eases/bulletins/coronaviruscovid19infectionsurvey/27may2022](http://www.ons.gov.uk/people-population-and-community/healthandsocialcare/conditionsanddis-eases/bulletins/coronaviruscovid19infectionsurvey/27may2022) (last accessed on 2 September 2022).

e26. Amalakanti S, Arepalli KVR, Jillella JP: Cognitive assessment in asymptomatic COVID-19 subjects. *Virusdisease* 2021; 32: 146–9.

e27. Nakamura ZM, Nash RP, Laughon SL, Rosenstein DL: Neuropsychiatric complications of COVID-19. *Curr Psychiatry Rep* 2021; 23: 25.

e28. Nalbandian A, Desai AD, Wan EY: Post-COVID-19 condition. *Annu Rev Med* 2022.

e29. Ahmadi Hekmatikar AH, Ferreira Junior JB, Shahrbanian S, Suzuki K: Functional and psychological changes after exercise training in Post-COVID-19 patients discharged from the hospital: a PRISMA-compliant systematic review. *Int J Environ Res Public Health* 2022; 19: 17.

e30. Arnold DT, Milne A, Samms E, Staddon L, Maskell NA, Hamilton FW: Are vaccines safe in patients with Long COVID? A prospective observational study. *Medrxiv* 2021.

e31. Uniklinik Köln: Post-COVID-Sprechstunde. www.uk-koeln.de/patienten-besucher/post-covid-zentrum/klinische-versorgung-und-ambulanz/en/c9474 (last accessed 02 January 2023).

e32. LMU Klinikum: Ein Jahr Corona-Pandemie in Deutschland. www.lmu-klinikum.de/aktuelles/pressemitteilungen/ein-jahr-corona-pandemie-in-deutschland/3dad60a0892ab5a5 (last accessed on 22 June 2022).

e33. Universität Regensburg: Anlaufstelle für junge Menschen mit Long Covid & Pädiatrischem Multiorgan Immunsyndrom (PMIS). www.kiss-regensburg.de/hc/aktuelles/detailsseite/news/anlaufstelle-fuer-junge-menschen-mit-long-covid-paediatrischem-multiorgan-immun-syndrom-pmis/ (last accessed on 2 September 2022).

e34. München Klinik Schwabing: Post-Covid-Syndrom (Long Covid): Long Covid Ambulanz: Hilfe bei Covid-Spätfolgen für Kinder, Jugendliche und junge Erwachsene bis 18 Jahre. www.muenchen-klinik.de/krankenhaus/schwabing/kinderkliniken/kinderheilkunde-jugendmedizin/spezialgebiete-kinder-klinik/kinder-immunologie-immun-schwache-immundefekt/therapie-kinder-immunologie-immundys-regulation/long-covid-kinder-jugendliche/ (last accessed on 2 September 2022).

- e35. Universitätsklinikum Carl Gustav Carus Dresden: Long-/Post-COVID-Ambulanz für Kinder und Jugendliche. www.uniklinikum-dresden.de/de/das-klinikum/kliniken-polikliniken-institute/kik/bereiche/ambulanz/anmeldung-postcovid (last accessed on 14 November 2022).
- e36. Universitätsklinikum Jena: Post-/ Long-Covid 19 Ambulanz für Kinder und Jugendliche./www.uniklinikum-jena.de/cscoc/Post_COVID_Zentrum/Post_COVID+Ambulanz/Long_+_Post_COVID+Ambulanz+Kinder+und+Jugendliche-p-1420.html (last accessed on 9 Januar 2023).
- e37. Charité – Universitätsmedizin Berlin: Post-COVID-Netzwerk der Charité – Universitätsmedizin Berlin. <https://pcn.charite.de/> (last accessed on 7 September 2022).
- e38. Bayerisches Staatsministerium für Gesundheit und Pflege: Modellprojekt „Post-COVID-Kids Bavaria“: Teilprojekt 2 „Post-COVID-Kids Bavaria—PCFC“ (Post-COVID Fatigue Center). www.stmgp.bayern.de/wp-content/uploads/2021/10/2021_post-covid-kids-bavaria-2.pdf (last accessed on 22 June 2022).
- e39. Bayerisches Staatsministerium für Gesundheit und Pflege: Modellprojekt „Post-COVID-Kids Bavaria“: Teilprojekt 1, „Post-COVID Kids Bavaria. Langzeiteffekte von Coronavirusinfektionen bei Kindern und Jugendlichen in Bayern: Erkennung und frühzeitige Behandlung von Folgeerkrankungen“. www.stmgp.bayern.de/wp-content/uploads/2021/10/2021_post-covid-kids-bavaria-1.pdf (last accessed on 22 June 2022).
- e40. Page MJ, McKenzie JE, Bossuyt PM, et al.: The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *J Clin Epidemiol* 2021; 134: 178–89.
- e41. Taquet M, Dercon Q, Harrison PJ: Six-month sequelae of post-vaccination SARS-CoV-2 infection: a retrospective cohort study of 10,024 breakthrough infections. *Brain Behav Immun* 2022; 103: 154–62.
- e42. Whitaker M, Elliott J, Chadeau-Hyam M, et al.: Persistent COVID-19 symptoms in a community study of 606,434 people in England. *Nat Commun* 2022; 13: 1957.
- e43. Anaya J-M, Rojas M, Salinas ML, et al.: Post-COVID syndrome. A case series and comprehensive review. *Autoimmun Rev* 2021; 20: 102947.
- e44. Ceban F, Ling S, Lui LMW, et al.: Fatigue and cognitive impairment in Post-COVID-19 syndrome: a systematic review and meta-analysis. *Brain Behav Immun* 2022; 101: 93–135.
- e45. Office for National Statistics (ONS) UK: Prevalence of ongoing symptoms following coronavirus (COVID-19) infection in the UK 2021, 1 April 2021. www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/conditionsanddiseases/bulletins/prevalenceofongoingsymptomsfollowingcoronaviruscovid19infectionintheuk/1april2021.
- e46. Kandemirli SG, Altundag A, Yildirim D, Tekcan Sanli DE, Saatci O: Olfactory bulb MRI and paranasal sinus CT findings in persistent COVID-19 anosmia. *Acad Radiol* 2021; 28: 28–35.
- e47. Konopka KE, Perry W, Huang T, Farver CF, Myers JL: Usual interstitial pneumonia is the most common finding in surgical lung biopsies from patients with persistent interstitial lung disease following infection with SARS-CoV-2. *EClinicalMedicine* 2021; 42: 101209.
- e48. Maccio U, Zinkernagel AS, Schuepbach R, et al.: Long-term persisting SARS-CoV-2 RNA and pathological findings: lessons learnt from a series of 35 COVID-19 autopsies. *Front Med (Lausanne)* 2022; 9: 778489.
- e49. Yang J-K, Lin S-S, Ji X-J, Guo L-M: Binding of SARS coronavirus to its receptor damages islets and causes acute diabetes. *Acta Diabetol* 2010; 47: 193–9.
- e50. Wendisch D, Dietrich O, Mari T, et al.: SARS-CoV-2 infection triggers profibrotic macrophage responses and lung fibrosis. *Cell* 2021; 184: 6243–6261.e27.
- e51. Puntmann VO, Carerj ML, Wieters I, et al.: Outcomes of cardiovascular magnetic resonance imaging in patients recently recovered from Coronavirus disease 2019 (COVID-19). *JAMA Cardiol* 2020; 5: 1265–73.
- e52. Guedj E, Campion JY, Dudouet P, et al.: 18F-FDG brain PET hypometabolism in patients with long COVID. *Eur J Nucl Med Mol Imaging* 2012; 48: 2823–33.
- e53. Stefanou MI, Palaodimou L, Bakola E, et al.: Neurological manifestations of long-COVID syndrome: a narrative review. *Ther Adv Chronic Dis* 2022; 13: 20406223221076890.
- e54. Moldofsky H, Patcai J: Chronic widespread musculoskeletal pain, fatigue, depression and disordered sleep in chronic post-SARS syndrome; a case-controlled study. *BMC Neurol* 2011; 11: 37.
- e55. Wu Y, Guo C, Tang L, et al.: Prolonged presence of SARS-CoV-2 viral RNA in faecal samples. *Lancet Gastroenterol Hepatol* 2020; 5: 434–5.
- e56. Sansone A, Mollaioli D, Limoncin E, et al.: The sexual long COVID (SLC): erectile dysfunction as a biomarker of systemic complications for COVID-19 long haulers. *Sex Med Rev* 2022; 10: 271–85.
- e57. Rathmann W, Kuss O, Kostev K: Incidence of newly diagnosed diabetes after Covid-19. *Diabetologia* 2022; 65: 949–54.

eMethods

Systematic literature search

For the statement “*Post-COVID-Syndrom (PCS)*” (post-COVID syndrome) of the German Medical Association (*Bundesärztekammer*) (6), a systematic search relating to the publication period 2020–2022 was carried out for guidelines, systematic review articles, and randomized controlled studies in medical databases such as the Cochrane COVID-19 study register, for which update searches for studies on humans are performed daily to weekly in numerous specialist databases (<https://community.cochrane.org/about-covid-19-study-register>). Other sources, such as MEDLINE, the WHO Register, and the Guidelines International Network database were also included in the search. To complete the data, a search was additionally carried out in the Cochrane COVID-19 study register for recent observational studies published in 2022. Peer-reviewed full-text articles were taken into consideration, as were preprints (as yet non-peer-reviewed specialist articles) published in MedRxiv (www.medrxiv.org/). No restrictions were set in terms of language. Searches were carried out between 19.07.2022 and 22.07.2022.

Publications that can be classified into the following PICO framework (population/participants, intervention, comparison group/control, outcome) were included: population/participants were defined as patients following the acute phase of COVID-19. If an intervention had been evaluated, it was defined as any intervention for prevention or treatment (pharmacological or otherwise) in participants, while comparison/control was defined as patients receiving a comparison intervention (studies comparing two interventions) or no intervention. Studies were initially included irrespective of the reported endpoints, with the focus placed on patient-relevant endpoints that evaluated improvement in physical, cognitive, or mental functioning, including quality of life, or symptom relief.

Evidence-based guidelines on PCS were selected as the study design or type of publication. If there were several versions of a guideline, only the most recent version was considered. In addition, systematic review articles and meta-analyses that either investigated interventions for the prevention or treatment of PCS or assessed observational studies on PCS onset were included. Randomized controlled trials that evaluated interventions for the prevention or treatment of PCS or individual symptoms (for example, anosmia) were also included. The search was complemented by observational studies (prospective and retrospective studies) that included a minimum of 1000 participants with symptoms following SARS-CoV-2 infection and that were published in 2022.

Studies that did not evaluate a control group, as well as comparative studies with a control group, were included. Here, the control group could be made up of participants that had previous SARS-CoV-2 infection or contracted COVID-19 but had not experienced any long-term symptoms, or also comprise a population that had no previous SARS-CoV-2 infection. SARS-CoV-2 infection was demonstrated via a PCR or antigen test in the acute phase, via an antibody test, or participants were asked about their previous infection status. No attempt was made to contact study authors for primary data.

Search results were downloaded in the Endnote databases and evaluated in each case by two independent reviewers for a

match with inclusion criteria. Any discrepancies were resolved by discussion. If this did not lead to a consensus, a third person was called in to assess whether a publication matched criteria in order to reach a consensus (e40) (eTable 1).

Systematic literature search: search history Long C for guidelines, SRs, and studies (cohort studies and RCTs)

Guideline search

Database search strategies

MEDLINE (via OVID)

Searches

- 1) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or

eTABLE 1

Guideline search

Media	Search 22 July 2022
ECRI*	Not available at the moment
G-I-N*	3
New South Wales government* (Australia)	1
National Covid-19 Clinical Evidence Taskforce* (Australia)	3
CADTH*	4
WHO*	0
CDC*	2
ECDC*	0
MEDLINE	57
TRIP	7

* Searched and screened: post covid, long covid, long term, post acute, sequelae, chronic covid, post intensive, inflammatory multisystem, multisystem inflammatory, PIMS, MIS; ECRI: <https://www.ecri.org/about/>; G-I-N, Guidelines International Network; CADTH, Canadian Agency for Drugs and Technologies in Health; WHO, World Health Organization; CDC, Centers for Disease Control and Prevention; ECDC, European Centre for Disease Prevention and Control

“postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 “2019 nCoV”).ti.

- 2) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 2019nCoV).ti.
- 3) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 coronavir*).ti.

- 4) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 coronavirus).ti.
- 5) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 COVID).ti.
- 6) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 COVID19).ti.
- 7) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 HCoV*).ti.
- 8) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 “nCov 2019”).ti.
- 9) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 “SARS CoV-2”).ti.
- 10) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 “SARS CoV 2”).ti.
- 11) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 SARSCoV-2).ti.
- 12) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 “SARSCoV-2”).ti.
- 13) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 “severe acute respiratory syndrome coronavirus 2”).ti.
- 14) (post-exertional malaise or PEM or “post-SARS-CoV-2” or “post-SARS-CoV-2” or “post corona virus disease” or “post coronavirus disease” or “post intensive care syndrome” or PICs or PIMS or “PIMS-TS” or MIS or “MIS-C” or MISC or MISTIC).ti.
- 15) ((multisystem inflammatory or multi-system inflammatory or inflammatory multisystem or inflammatory multi-system) adj2 (syndrom* or disease*)).ti.
- 16) or/1–15
- 17) exp Practice Guideline/
- 18) ((practice or treatment* or consensus or clinical) adj guideline*).ab. /freq=3
- 19) guideline*.ti,kw,kf.
- 20) or/17–19
- 21) 16 and 20
- 22) limit 21 to last 2 years
- TRIP**
 (“long COVID” or “long COVID-19” or “long COVID19” or haul* “chronic COVID” or “chronic COVID-19” or “chronic COVID19” or “post-acute” or “postacute” or “post COVID” or “post COVID-19” or “post COVID19” “long term COVID” or “long term COVID-19” or “long term COVID19” “post-exertional malaise” or “post-SARS-CoV-2” or “post-SARS-CoV-2” or “post corona virus disease” or “post coronavirus disease” “chronic COVID” or “chronic COVID-19” or “chronic COVID19” or (pacs OR sequelae* OR “late complication” OR “late complications”) AND (covid OR covid-19 OR covid19) “post intensive care syndrome” or “persistent COVID” or “persistent COVID-19” or “persistent COVID19” or (“post intensive care syndrome” OR “persistent covid” OR “persistent covid-19” OR “persistent covid19”) AND (covid OR covid-19 OR covid19) “late COVID” or “late COVID-19” OR “late COVID19” (“inflammatory multi-system syndrome” OR “inflammatory multisystem syndrome” OR “inflammatory multi-system disease” OR “inflammatory multisystem disease” OR pims OR “pims-ts” OR “multisystem inflammatory disease” OR “multi-system inflammatory disease” OR “multi-system inflammatory syndrome” OR “multisystem inflammatory syndrome” OR mis OR “mis-c” OR misc OR mistic) AND (covid OR covid19 OR covid-19) from_date:2021

Evidence syntheses

1) Evidence Aid Coronavirus (Covid-19)

Searched and screened: post covid, long covid, long term, post acute, sequelae, chronic covid, post intensive, inflammatory multisystem, multisystem inflammatory, PIMS, MIS

2) Usher Network for COVID-19 Evidence Reviews

eTABLE 2	
Evidence syntheses	
	Search 19 July 2022
Evidence Aid	6
Usher	27
ESP-VA	57
LOVE	312
MEDLINE	274
Total	676
Total (after deduplication)	483

Searched and screened: post covid, long covid, long term, post acute, sequelae, chronic covid, post intensive, inflammatory multisystem, multisystem inflammatory, PIMS, MIS

3) U.S. Veterans’ Affairs (VA) Evidence Synthesis Program

Searched and screened: post covid, long covid, long term, post acute, sequelae, chronic covid, post intensive, inflammatory multisystem, multisystem inflammatory, PIMS, MIS

4) L*OVE

(“long COVID” or “long COVID-19” or “long COVID19” or haul* or “chronic COVID” or “chronic COVID-19” or “chronic COVID19” or “post-acute” or “postacute” or “post COVID” or “post COVID-19” or “post COVID19” or “long term COVID” or “long term COVID-19” or “long term COVID19” or “post-exertional malaise” or “post-SARS-CoV-2” or “post-SARS-CoV-2” or “post corona virus disease” or “post coronavirus disease” or “chronic COVID” or “chronic COVID-19” or “chronic COVID19” or PACS or sequelae* or “late sequelae” or “post intensive care syndrome” or “persistent COVID” or “persistent COVID-19” or “persistent COVID19” or “post-infectious” or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or “late COVID” or “late COVID-19” OR “late COVID19” or “inflammatory multi-system syndrome” or “inflammatory multisystem syndrome” or “inflammatory multi-system disease” or “inflammatory multisystem disease” or PIMS or “PIMS-TS” or “multisystem inflammatory disease” or “multi-system inflammatory disease” or “multi-system inflammatory syndrome” or “multisystem inflammatory syndrome” or MIS or “MIS-C” or MISC or MISTIC)

Filtered by systematic review

2021: 198

2022: 14

5) Medline (via Ovid)

Searches

- 1) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 “2019 nCoV”).ti.
- 2) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 2019nCoV).ti.
- 3) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 coronavir*).ti.
- 4) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 coronovir).ti.
- 5) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 COVID).ti.
- 6) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 COVID19).ti.
- 7) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 HCoV*).ti.
- 8) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 “nCov 2019”).ti.
- 9) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 “SARS CoV-2”).ti.
- 10) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or

“postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 “SARS CoV 2”).ti.

- 11) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 SARSCoV-2).ti.
- 12) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 “SARSCoV 2”).ti.
- 13) ((long or haul* or chronic or post-acute or postacute or post or long term or chronic or sequelae* or persistent* or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or late) adj4 “severe acute respiratory syndrome coronavirus 2”).ti.
- 14) (post-exertional malaise or PEM or “post-SARS-CoV-2” or “post-SARS-CoV-2” or “post corona virus disease” or “post coronavirus disease” or “post intensive care syndrome” or PICs or PIMS or “PIMS-TS” or MIS or “MIS-C” or MISC or MISTIC).ti.
- 15) ((multisystem inflammatory or multi-system inflammatory or inflammatory multisystem or inflammatory multi-system) adj2 (syndrom* or disease*)).ti.
- 16) or/1–15
- 17) cochrane database of systematic reviews.jn. or search*.tw. or meta analysis.pt. or medline.tw. or systematic review.tw. or systematic review.pt.

18) 16 and 17

19) limit 18 to dt=20200101–20220720

2021: 140

2022: 134

Randomized controlled trials

CCSR

“long COVID” or “long COVID-19” or “long COVID19” or haul* or “chronic COVID” or “chronic COVID-19” or “chronic COVID19” or “post-acute” or “postacute” or “post COVID” or “post COVID-19” or “post COVID19” or “long term COVID” or

“long term COVID-19” or “long term COVID19” or “post-exer-

eTABLE 3

Randomized controlled studies

Database	Search 19 July 2022
CCSR	310 ref. (104 studies)
WHO COVID-19 DB	428
Total	732
Total (after deduplication)	716

tional malaise” or “PEM” or “post-SARS-CoV-2” or “post-SARS-CoV-2” or “post corona virus disease” or “post coronavirus disease” or “chronic COVID” or “chronic COVID-19” or “chronic COVID19” or PACS or sequelae* or “late sequelae” or “post intensive care syndrome” or PICs or “persistent COVID” or “persistent COVID-19” or “persistent COVID19” or “post-infectious” or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or “late COVID” or “late COVID-19” OR “late COVID19” or “multi-system syndrome” or “multisystem syndrome” or “inflammatory multisystem” or “inflammatory multi-system” or PIMS or “PIMS-TS” or “multisystem Inflammatory” or “multi-system inflammatory” or MIS or “MIS-C” or MISC or MISTIC

Study characteristics

- 1) Intervention assignment: randomized, quasi-randomized, unclear
 - 2) Study design: parallel/crossover, unclear
- Results available: report results

WHO COVID-19 Global literature on coronavirus disease

i: (“long COVID” OR “long COVID-19” OR “long COVID19” OR haul* OR “chronic COVID” OR “chronic COVID-19” OR “chronic COVID19” OR “post-acute” OR “postacute” OR “post COVID” OR “post COVID-19” OR “post COVID19” OR “long term COVID” OR “long term COVID-19” OR “long term COVID19” OR “post-exertional malaise” OR “PEM” OR “post-SARS-CoV-2” OR “post-SARS-CoV-2” OR “post corona virus disease” OR “post coronavirus disease” OR “chronic COVID” OR “chronic COVID-19” OR “chronic COVID19” OR pacs OR sequelae* OR “late sequelae” OR “post intensive care syndrome” OR pics OR “persistent COVID” OR “persistent COVID-19” OR “persistent COVID19” OR “post-infectious” OR “postinfectious” OR “post-infection” OR “postinfection” OR “late complication” OR “late complications” OR “late COVID” OR “late COVID-19” OR “late COVID19” OR “multi-system syndrome” OR “multisystem syndrome” OR “inflammatory multisystem” OR “inflammatory multi-system” OR pims OR “PIMS-TS” OR “multisystem Inflammatory” OR “multi-system inflammatory” OR mis OR “MIS-C” OR misc OR mistic)

AND

(random* OR placebo OR trial OR groups OR “phase 3” OR “phase3” OR p3 OR “pIII”)

Cohort studies

CCSR

“long COVID” or “long COVID-19” or “long COVID19” or haul* or “chronic COVID” or “chronic COVID-19” or “chronic COVID19” or “post-acute” or “postacute” or “post COVID” or “post COVID-19” or “post COVID19” or “long term COVID” or “long term COVID-19” or “long term COVID19” or “post-exer-

eTABLE 4	
Cohort studies	
	Search 19 July 2022
CCSR	6330

tional malaise” or “PEM” or “post-SARS-CoV-2” or “post-SARS-CoV-2” or “post corona virus disease” or “post coronavirus disease” or “chronic COVID” or “chronic COVID-19” or “chronic COVID19” or PACS or sequelae* or “late sequelae” or “post intensive care syndrome” or PICs or “persistent COVID” or “persistent COVID-19” or “persistent COVID19” or “post-infectious” or “postinfectious” or “post-infection” or “postinfection” or “late complication” or “late complications” or “late COVID” or “late COVID-19” OR “late COVID19” or “multi-system syndrome” or “multisystem syndrome” or “inflammatory multisystem” or “inflammatory multi-system” or PIMS or “PIMS-TS” or “multisystem Inflammatory” or “multi-system inflammatory” or MIS or “MIS-C” or MISC or MISTIC

Study design

Case series/case control/cohort; cross-sectional; other; time series; single arm/controlled before after; unclear

Cochrane COVID-19 Study Register (CCSR)

The register contains study reports from several sources, including:

weekly searches of PubMed;

daily searches of ClinicalTrials.gov;

weekly searches of Embase.com;

weekly searches of the WHO International Clinical Trials Registry Platform (ICTRP);

monthly searches of the Cochrane Central Register of Controlled Trials (CENTRAL).

Questions on the article in issue 4/2023:

Post-COVID Syndrome

The submission deadline is 26 January 2024. Only one answer is possible per question.

Please select the answer that is most appropriate.

Question 1

According to WHO estimates, what percentage of individuals infected with SARS-CoV-2 develop post-COVID syndrome (as of 2021)?

- a) 1–3%
- b) 5–10%
- c) 10–20%
- d) 25–30%
- e) 30–40%

Question 2

Which of the following biographical factors are both currently known risk factors for post-COVID syndrome?

- a) Young age, Asian
- b) Advanced age, male sex
- c) Advanced age, Caucasian
- d) Middle age, female sex
- e) Young age, male sex

Question 3

How high was the prevalence of PCS among triple-vaccinated individuals in the UK's "COVID Surveillance Study" (as of 2022)?

- a) Under 5%
- b) Approximately 10%
- c) Approximately 15%
- d) Under 2%
- e) Over 15%

Question 4

Which vasoconstrictor was elevated in a third of patients with PCS in the endothelial dysfunction test 6 months following mild COVID-19 infection?

- a) Adrenaline
- b) Vasopressin
- c) Angiotensin
- d) Nicotine
- e) Endothelin-1

Question 5

What does the abbreviation PICS stand for in the text?

- a) Post-interventional covid syndrome
- b) Post-intensive care syndrome
- c) Post-infectious covid syndrome
- d) Post-infectious cardiac syndrome
- e) Post-interventional cardiac syndrome

Question 6

According to the WHO definition, what is the earliest point at which post-COVID syndrome can be diagnosed in a patient with symptoms persisting for at least 2 months?

- a) > 2 Weeks following acute infection
- b) > 4 Weeks following acute infection
- c) > 8 Weeks following acute infection
- d) > 12 Weeks following acute infection
- e) > 16 Weeks following acute infection

Question 7

Which term is used for the sparing, dosed management of a patient's energy resources in the case of chronic fatigue syndrome?

- a) Tiptoeing
- b) Walking
- c) Crawling
- d) Sneaking
- e) Pacing

Question 8

The text mentions which important differential diagnosis that needs to be borne in mind in the case of suspected PCS due to its high incidence (approximately 8%) in the adult population?

- a) Hitherto undiagnosed malignancies
- b) Giardiasis
- c) Depression
- d) Previous myocardial infarction
- e) Hepatitis

Question 9

Autoantibodies can be detected in the acute phase of disease and in PCS. Autoantibodies against which of the following structures (also mentioned in the text) have already been detected in patients with PCS?

- a) Interleukin-1 and GABA-A receptors
- b) Potassium channels and Fc receptors
- c) Sodium channels and RAS proteins
- d) Sodium-potassium ATPase and dopamine receptors
- e) Type-1 interferons and G-protein-coupled receptors

Question 10

According to the article, which symptom does not belong to the typical gastrointestinal symptoms of PCS?

- a) Reflux
- b) Nausea
- c) Diarrhea
- d) Loss of appetite
- e) Abdominal pain

eLiteratur - Ergänzung

Ergebnisse der systematischen Literaturrecherche, die in den Übersichtsartikel eingeflossen sind, ohne explizit zitiert zu werden

- Abdelalim Aa, Mohamady A. A. Elsayed R. A. Elawady M. A. Ghallab A. F.: Corticosteroid nasal spray for recovery of smell sensation in COVID-19 patients: a randomized controlled trial. *American journal of otolaryngology* 2021; 42(2): 102884.
- Abdel-Gawad M, Zaghoul MS, Abd-Elsalam S, et al.: Post-COVID-19 Syndrome Clinical Manifestations: A Systematic Review. *Antiinflamm Antiallergy Agents Med Chem* 2022; 03: 28.
- Abdelwahab N, Ingraham N. E. Nguyen N. Siegel L. Silverman G. Sahoo H. S. Pakhomov S. Morse L. R. Billings J. Usher M. G. Melnik T. E. Tignanelli C. J. Ikramuddin F.: Predictors of Post-Acute Sequelae of COVID-19 Development and Rehabilitation: a Retrospective Study. *Archives of physical medicine and rehabilitation* 2022.
- Ahmad SJ, Feigen CM, Vazquez JP, Kobets AJ, Altschul DJ: Neurological Sequelae of COVID-19. *J Integr Neurosci* 2022; 21(3): 77.
- Ahmadi Hekmatikar AH, Ferreira Junior JB, Shahrbanian S, Suzuki K: Functional and Psychological Changes after Exercise Training in Post-COVID-19 Patients Discharged from the Hospital: A PRISMA-Compliant Systematic Review. *Int J Environ Res Public Health* 2022; 19(4): 17.
- Ahmed JO, Ahmad SA, Hassan MN, et al.: Post COVID-19 neurological complications; a meta-analysis. *Ann Med Surg (Lond)* 2022; 76: 103440.
- Ahmed H, Patel K, Greenwood D, et al.: LONG-TERM CLINICAL OUTCOMES IN SURVIVORS OF CORONAVIRUS OUTBREAKS AFTER HOSPITALISATION OR ICU ADMISSION: A SYSTEMATIC REVIEW AND META-ANALYSIS OF FOLLOW-UP STUDIES. *Medrxiv* 2020: 2020.04.16.20067975.
- Akbarialiabad H, Taghrir MH, Abdollahi A, et al.: Long COVID, a comprehensive systematic scoping review. *Infection* 2021; 49(6): 1163–86.
- Al-Aly Z, Bowe B, Xie Y: Long COVID after breakthrough SARS-CoV-2 infection. *Nat Med* 2022; 28(7): 1461–7.
- Alanazi, T. K. A., Alahmari, N. F. A., Qubays, F. E. I., Alenezi, S. H. ibraheem and Alenezi, M. F. M.: Post COVID-19 Organizing Pneumonia: A Systematic Review and Meta-analysis. *Journal of Pharmaceutical Research International* 2021: 259–70.
- Alahyari S, Moradi M, Rajaeinejad M, Jalaeikhoo H: Post-COVID-19 hematologic complications: a systematic review. *Expert Rev Hematol* 2022; 15(6): 539–46
- Alghamdi Hy, Alrashed A. M. Jawhari A. M. Abdel-Moneim A. S.: Neuropsychiatric symptoms in post-COVID-19 long haulers. *Acta neuropsychiatrica* 2022: 1–12.
- Alkodaymi MS, Omrani OA, Fawzy NA, et al.: Prevalence of post-acute COVID-19 syndrome symptoms at different follow-up periods: a systematic review and meta-analysis. *Clin Microbiol Infect* 2022; 28(5): 657–66.
- Almas T, Malik J, Alsubai AK, et al.: Post-acute COVID-19 syndrome and its prolonged effects: An updated systematic review. *Ann Med Surg (Lond)* 2022: 103995.
- Alosaimi B, AlFayyad I, Alshuaibi S, et al.: Cardiovascular complications and outcomes among athletes with COVID-19 disease: a systematic review. *BMC sports science, medicine & rehabilitation* 2022; 14(1): 74.

- AlRadini Fa, Alamri F. Aljahany M. S. Almuzaini Y. Alsofayan Y. Khan A. Albogami N. Abdulrahim M. Almogbil A. Aлахmari A.: Post-acute COVID-19 condition in Saudi Arabia: a national representative study. *Journal of infection and public health* 2022; 15(5): 526–32.
- Amdal CD, Pe M, Falk RS, et al.: Health-related quality of life issues, including symptoms, in patients with active COVID-19 or post COVID-19; a systematic literature review. *Qual Life Res* 2021; 30(12): 3367–81.
- Anand A, Rain M, Puri GD, et al.: EFFICACY OF YOGA-BASED BREATHING INTERVENTION IN COVID-19 POSITIVE, POST-COVID AND HEALTH CARE WORKERS: A RANDOMIZED CLINICAL TRIAL. *Psychosomatic Medicine* 2022; 84(5): A7-A7.
- Antonelli M, Pujol JC, Spector TD, Ourselin S, Steves CJ: Risk of long COVID associated with delta versus omicron variants of SARS-CoV-2. *The Lancet* 2022; 399(10343): 2263–4.
- Antoniou KM, Vasarmidi E, Russell AM, et al.: European Respiratory Society Statement on Long COVID-19 Follow-Up. *Eur Respir J* 2022; 10: 10.
- Arun N, Ashish S, Gayathri D, et al.: A systematic review and meta-analysis of Long COVID symptoms. *Medrxiv* 2022.
- Atlas K, Farber JS, Shields K, Lebet R: Multisystem Inflammatory Syndrome in Children in the Critical Care Setting. *Crit Care Nurse* 2022; 42(1): 13–22.
- Ayed M, Alsaffar Z. Bahzad Z. Buhamad Y. Abdulkareem A. AlQattan A. Embaireeg A. Kartam M. Alkandari H.: Coronavirus infection in neonates: neurodevelopmental outcomes at 18 months of age. *Medrxiv* 2022.
- Ayoubkhani D, Bosworth M. L. King S. Pouwels K. B. Glickman M. Nafilyan V. Zaccardi F. Khunti K. Alwan N. A. Walker A. S.: Risk of Long Covid in people infected with SARS-CoV-2 after two doses of a COVID-19 vaccine: community-based, matched cohort study. *Medrxiv* 2022.
- Ayoubkhani D, Bermingham C. Pouwels K. B. Glickman M. Nafilyan V. Zaccardi F. Khunti K. Alwan N. A. Walker A. S.: Trajectory of long covid symptoms after covid-19 vaccination: community based cohort study. *BMJ* 2022; 377: e069676.
- Badenoch JB, Rengasamy ER, Watson C, et al.: Persistent neuropsychiatric symptoms after COVID-19: a systematic review and meta-analysis. *Brain commun* 2022; 4(1): fcab297.
- Badran Bw, Huffman S. M. Dancy M. Austelle C. W. Bikson M. Kautz S. A. George M. S.: A pilot randomized controlled trial of supervised, at-home, self-administered transcutaneous auricular vagus nerve stimulation (taVNS) to manage long COVID symptoms. *Research square* 2022.
- Ballouz T, Menges D. Anagnostopoulos A. Domenghino A. Aschmann H. E. Frei A. Fehr J. S. Puhan M. A.: Natural course of post COVID-19 condition and implications for trial design and outcome selection: a population-based longitudinal cohort study. *Medrxiv* 2022.
- Banerjee M, Pal R, Dutta S: Risk of incident diabetes post-COVID-19: A systematic review and meta-analysis. *Prim Care Diabetes* 2022; 30: 30.
- Barros Laf, Oliveira V. D. S. Morais W. J. Dias L. A. Portugues J. A. Soares M. B. Aquino E. C. Pinto R. M.: Pediatric inflammatory multisystemic syndrome in Brazil: sociodemographic characteristics and risk factors to death. *Jornal de pediatria* 2022.
- Behnood SA, Shafran R, Bennett SD, et al.: Persistent symptoms following SARS-CoV-2 infection amongst children and young people: A meta-analysis of controlled and uncontrolled studies. *J Infect* 2022; 84(2): 158–70.

- Belcaro G, Cornelli U. Cesarone M. R. Scipione C. Scipione V. Hu S. Feragalli B. Corsi M. Cox D. Cotellesse R. Hosoi M. Burki C.: Preventive effects of Pycnogenol® on cardiovascular risk factors (including endothelial function) and microcirculation in subjects recovering from coronavirus disease 2019 (COVID-19). *Minerva medica* 2021.
- Belkacemi M, Baouche H. Gomis S. Lassalle M. Couchoud C. Rein registry: Long-lasting clinical symptoms 6 months after COVID-19 infection in the French national cohort of patients on dialysis. *Journal of nephrology* 2022; 35(3): 787–93.
- Benzarti W, Toulgui E, Prefaut C, Chamari K, Ben Saad H: General practitioners should provide the cardiorespiratory rehabilitation 'minimum advice' for long COVID-19 patients. *Libyan j* 2022; 17(1): 2009101.
- Bhattacharjee PNS: A Systematic Review & Metaethnography of the lived experiences of long COVID patients (preprint) 2022/00. doi:10.21203/rs.3.pex-1897/v1.
- Bhogal J K, Mills F. Dennis A. Spoiala C. Milward J. Saeed S. Jones L. F. Weston D. Carter H.: The Effects of Messaging on Expectations and Understanding of Long COVID: an Online Randomised Trial. *Medrxiv* 2022.
- Blankenburg J, Wekenborg M. K. Reichert J. Kirsten C. Kahre E. Haag L. Schumm L. Czyborra P. Berner R. Armann J. P.: Comparison of mental health outcomes in seropositive and seronegative adolescents during the COVID19 pandemic. *Scientific reports* 2022; 12(1): 2246.
- Bloise S, Isoldi S. Marcellino A. De Luca E. Dilillo A. Mallardo S. Martucci V. Sanseviero M. Del Giudice E. Iorfida D. Leone R. Testa A. Frasacco B. Gizzone P. Proietti Ciolfi C. Sinceri A. Zuliani F. Zanardi E. Gambarotto A. Lisa Grandinetti A. Ventriglia F. Lubrano R.: Clinical picture and long-term symptoms of SARS-CoV-2 infection in an Italian pediatric population. *Italian journal of pediatrics* 2022; 48(1): 79.
- Bogariu AM, Dumitrascu DL: Digestive involvement in the Long-COVID syndrome. *Med* 2022; 95(1): 5–10.
- Bossley Cj, Kavaliunaite E. Harman K. Cook J. Ruiz G. Gupta A.: Post-acute COVID-19 outcomes in children requiring hospitalisation. *Scientific reports* 2022; 12(1): 8208.
- Borch L, Holm M, Knudsen M, Ellermann-Eriksen S, Hagstroem S: Long COVID symptoms and duration in SARS-CoV-2 positive children - a nationwide cohort study. *Eur J Pediatr* 2022; 181(4): 1597–607.
- Botek M, Krejci J. Valenta M. McKune A. Sladeckova B. Konecny P. Klimesova I. Pastucha D.: Molecular Hydrogen Positively Affects Physical and Respiratory Function in Acute Post-COVID-19 Patients: a New Perspective in Rehabilitation. *International journal of environmental research and public health* 2022; 19(4).
- Bourmistrova NW, Solomon T, Braude P, Strawbridge R, Carter B: Long-term effects of COVID-19 on mental health: A systematic review. *J Affect Disord* 2022; 299: 118–25.
- Bowyer R C E, Huggins C. Toms R. Shaw R. J. Hou B. Thompson E. J. Kwong A. S. F. Williams D. M. Kibble M. Ploubidis G. B. Timpson N. J. Sterne J. A. C. Chaturvedi N. Steves C. J. Tilling K. Silverwood R. J.: Characterising patterns of COVID-19 and long COVID symptoms: evidence from nine UK longitudinal studies. *Medrxiv* 2022.
- Bulyanko Sa, Soldatskiy Y. L. Novikova Y. Y. Ovsyannikov D. Y. Edgem S. R. Glazyrina A. A.: Differential diagnosis of parapharyngeal abscess with multisystem inflammatory syndrome in children associated with COVID-19. *Vestnik otorinolaringologii* 2022; 87(2): 70–5.
- Buonsenso D, Mariani F. Pierri L. Morello R. Yock-Corrales A. Del Aguila O. Lazzareschi I. Zampino G. Nunziata F. Valentini P. Lo Vecchio A.: Association between Coagulation Profile and Clinical Outcome in Children with SARS-CoV-2 Infection or MIS-C: a Multicenter Cross-Sectional Study. *Children (Basel, Switzerland)* 2022; 9(2).

- Cabrera Martimbianco AL, Pacheco RL, Bagattini AM, Riera R: Frequency, signs and symptoms, and criteria adopted for long COVID-19: A systematic review. *Int J Clin Pract* 2021; 75(10): e14357.
- Castanares-Zapatero D, Chalon P, Kohn L, et al.: Pathophysiology and mechanism of long COVID: a comprehensive review. *Ann Med* 2022; 54(1): 1473–87.
- Carazo S, Skowronski D. M. Laforce R. J. Talbot D. Falcone E. L. Laliberte D. Denis G. Deshaies P. Hegg-Deloye S. De Serres G.: Physical, psychological and cognitive profile of post-COVID condition in healthcare workers, Quebec, Canada. *Medrxiv* 2022.
- Cares-Marambio K, Montenegro-Jiménez Y, Torres-Castro R, et al.: Prevalence of potential respiratory symptoms in survivors of hospital admission after coronavirus disease 2019 (COVID-19): A systematic review and meta-analysis. *Chronic respiratory disease* 2021; 18: 14799731211002240.
- Carson E, Hemenway AN: A Scoping Review of Pharmacological Management of Postacute Sequelae of Severe Acute Respiratory Syndrome Coronavirus 2 Infection in 2021. *Am J Ther* 2022; 29(3): e305-e321.
- Caspersen Ih, Magnus P. Trogstad L.: Excess risk and clusters of symptoms after COVID-19 in a large Norwegian cohort. *European journal of epidemiology* 2022.
- Ceban F, Leber A, Jawad MY, et al.: Registered clinical trials investigating treatment of long COVID: a scoping review and recommendations for research. *Infect Dis (Lond)* 2022; 54(7): 467–77.
- Ceban F, Ling S, Lui LMW, et al.: Fatigue and cognitive impairment in Post-COVID-19 Syndrome: A systematic review and meta-analysis. *Brain Behav Immun* 2022; 101: 93–135.
- Centeno-Cortez AK, Diaz-Chavez B, Santoyo-Saavedra DR, Alvarez-Mendez PA, Pereda-Samano R, Acosta-Torres LS: [Respiratory physiotherapy in post-acute COVID-19 adult patients: Systematic review of literature]. *Rev* 2022; 60(1): 59–66.
- Cha C, Baek G: Symptoms and management of long COVID: A scoping review. *J Clin Nurs* 2021; 15: 15.
- Chai C, Chen K. Li S. Cheng G. Wang W. Wang H. Wei D. Peng C. Sun Q. Tang Z.: Effect of elevated fasting blood glucose level on the 1-year mortality and sequelae in hospitalized COVID-19 patients: a bidirectional cohort study. *Journal of medical virology* 2022; 94(7): 3240–50.
- Chen C, Hauptert SR, Zimmermann L, Shi X, Fritsche LG, Mukherjee B: Global Prevalence of Post COVID-19 Condition or Long COVID: A Meta-Analysis and Systematic Review. *J Infect Dis* 2022; 16: 16.
- Chen H, Shi H, Liu X, Sun T, Wu J, Liu Z: Effect of Pulmonary Rehabilitation for Patients With Post-COVID-19: A Systematic Review and Meta-Analysis. *Front Med (Lausanne)* 2022; 9: 837420.
- Choudary Mk, Jain S. Meena S. Meena D. Gour A. SHARMA S.: Co-morbidities and Complications in COVID-19 Recovered Patients in Bhilwara District, Rajasthan, India: a Descriptive Study. *Journal of clinical and diagnostic research* 2022; 16(4): LC33-LC36.
- Clift Ak, Ranger T. A. Patone M. Coupland C. A. C. Hatch R. Thomas K. Hippisley-Cox J. Watkinson P.: Neuropsychiatric Ramifications of Severe COVID-19 and Other Severe Acute Respiratory Infections. *JAMA psychiatry* 2022.
- Cohen J M, Ladhani S. Carter M. J. Cheung R. Evelina Pims- T. S. Study Group: Lower Risk of Multisystem Inflammatory Syndrome in Children (MIS-C) with the Delta and Omicron variants of SARS-CoV-2. *Medrxiv* 2022.

- Cohen Jm, Carter M. J. Ronny Cheung C. Ladhani S. Evelina Pims- T. S. Study Group: Lower Risk of Multisystem Inflammatory Syndrome in Children (MIS-C) with the Delta and Omicron variants of SARS-CoV-2. *Clinical infectious diseases* 2022.
- COVID-19 Critical Intelligence Unit: Breathlessness post COVID-19 2022.
- COVID-19 Critical Intelligence Unit: Exercise and long COVID 2022.
- COVID-19 Critical Intelligence Unit: Post-acute sequelae of COVID-19 (long COVID) - What is the evidence on the prevalence, severity, diagnosis and management of long-COVID?: COVID-19 Critical Intelligence Unit 2022.
- Crankson S, Pokhrel S. Anokye N. K.: Determinants of COVID-19-Related Length of Hospital Stays and Long COVID in Ghana: a Cross-Sectional Analysis. *International journal of environmental research and public health* 2022; 19(1).
- Crivelli L, Palmer K, Calandri I, et al.: Changes in cognitive functioning after COVID-19: A systematic review and meta-analysis. *Alzheimer's & dementia the journal of the Alzheimer's Association* 2022.
- D. E. Sire A, Andrenelli E, Negrini F, et al.: Rehabilitation and COVID-19: a rapid living systematic review by Cochrane Rehabilitation Field updated as of December 31st, 2020 and synthesis of the scientific literature of 2020. *European journal of physical and rehabilitation medicine* 2021.
- Daniel D-R-M, Marco Antonio D-M, Omar Yaxmehen B-C, et al.: Long-term manifestations and modifiers of prevalence estimates of the post-COVID-19 syndrome: A systematic review and meta-analysis. *Medrxiv* 2021.
- D'Ascanio L, Vitelli F. Cingolani C. Maranzano M. Brenner M. J. Di Stadio A.: Randomized clinical trial "olfactory dysfunction after COVID-19: olfactory rehabilitation therapy vs. intervention treatment with Palmitoylethanolamide and Luteolin": preliminary results. *European review for medical and pharmacological sciences* 2021; 25(11): 4156–62.
- Decary S, Dugas M, Stefan T, Langlois L, Skidmore B, Bhéreur A, and LeBlanc A: Care Models for Long COVID – A Living Systematic Review. First Update. SPOR Evidence Alliance, COVID-END Network 2021.
- Degen Cv, Mikuteit M. Niewolik J. Schroder D. Vahldiek K. Mucke U. Heinemann S. Muller F. Behrens G. M. N. Klawonn F. Dopfer-Jablonka A. Steffens S.: Self-reported Tinnitus and Vertigo or Dizziness in a Cohort of Adult Long COVID Patients. *Frontiers in neurology* 2022; 13: 884002.
- d'Ettorre G, Gentilini Cacciola E, Santinelli L, et al.: Covid-19 sequelae in working age patients: A systematic review. *J Med Virol* 2022; 94(3): 858–68.
- Dhooria S, Chaudhary S. Sehgal I. S. Agarwal R. Arora S. Garg M. Prabhakar N. Puri G. D. Bhalla A. Suri V. Yaddanapudi L. N. Muthu V. Prasad K. T. Aggarwal A. N.: High-dose versus low-dose prednisolone in symptomatic patients with post-COVID-19 diffuse parenchymal lung abnormalities: an open-label, randomised trial (Acronym: COLD-STER). *The european respiratory journal* 2021; 59(2).
- Dhooria S, Maturu V. N. Talwar D. Kumar S. Handa A. Agrawal P. N. Jindal A. Tampi P. S. Goyal A. Maskey D. Aggarwal A. N. Behera D. Jindal S. K.: A multicenter survey study of antifibrotic use for symptomatic patients with post-COVID-19 interstitial lung abnormalities. *Lung India* 2022; 39(3): 254–60.
- Dixit AK, Giri N, Singh S: Exploring the scope of homoeopathy in combating the unfortunate consequences of post-COVID-19 survivors based on non-COVID conditions: a narrative review. *J Complement Integr Med* 2021; 15: 15.
- Donnachie E, Hapfelmeier A. Linde K. Tauscher M. Gerlach R. Greissel A. Schneider A.: Incidence of Post-Covid Syndrome and Associated Symptoms in Outpatient Care in Bavaria, Germany. *Medrxiv* 2022.

- Dorri M, Bazargany MHM, Khodaparast Z, et al.: Psychological Problems and Reduced Health-Related Quality of Life in the COVID-19 Survivors. *Journal of affective disorders reports* 2021; 6: 100248.
- Dryden M, Mudara C. Vika C. Blumberg L. Mayet N. Cohen C. Tempia S. Parker A. Nel J. Perumal R. Groome M. Conradie F. Ndjeka N. Sigfrid L. Merson L. Jassat W.: Post COVID-19 Condition in South Africa: 3-month follow-up after hospitalisation with SARS-CoV-2. *Medrxiv* 2022.
- Durstenfeld MS, Sun K, Tahir PM, et al.: Cardiopulmonary exercise testing to evaluate post-acute sequelae of COVID-19 ("Long COVID"): a systematic review and meta-analysis. *medRxiv* 2022; 16: 16.
- El Tal T, Morin M. P. Morris S. Farrar D. K. Berard R. A. Kakkar F. Moore Hepburn C. Baerg K. Beaufile C. Bennett T. L. Benseler S. M. Beaudoin-Bussieres G. Chan K. Cyr C. Dahdah N. Donner E. J. Drouin O. Edjoc R. Eljaouhari M. Embree J. E. Farrell C. Finzi A. Forgie S. Giroux R. Kang K. T. King M. Laffin Thibodeau M. Lang B. Laxer R. M. Luu T. M. McCrindle B. W. Orkin J. Papenburg J. Pound C. M. Price V. E. Proulx-Gauthier J. P. Purewal R. Sadarangani M. Salvadori M. I. Thibeault R. Top K. A. Viel-Therault I.: Epidemiology and role of SARS-CoV-2 Linkage in Paediatric Inflammatory Multisystem Syndrome (PIMS): a Canadian Paediatric Surveillance Program National Prospective Study. *Medrxiv* 2022.
- Emecen An, Keskin S. Turunc O. Suner A. F. Siyve N. Basoglu Sensoy E. Dinc F. Kilinc O. Avkan Oguz V. Bayrak S. Unal B.: The presence of symptoms within 6 months after COVID-19: a single-center longitudinal study. *Irish journal of medical science* 2022.
- Esmailzadeh H, Sanaei Dashti A. Mortazavi N. Fatemian H. Vali M.: Persistent cough and asthma-like symptoms post COVID-19 hospitalization in children. *BMC infectious diseases* 2022; 22(1): 244.
- Evans RA, McAuley H, Harrison EM, et al.: Correction to *Lancet Respir Med* 2021; 9: 1275–87 (The *Lancet Respiratory Medicine* (2021)). *Lancet respiratory medicine* 2022; 10(1): e9.
- Fabbri L, Moss S, Khan F, et al.: Post-viral parenchymal lung disease following COVID-19 and viral pneumonitis hospitalisation: A systematic review and meta-analysis. *Medrxiv* 2021.
- Fabbri L, Moss S, Khan FA, et al.: Parenchymal lung abnormalities following hospitalisation for COVID-19 and viral pneumonitis: a systematic review and meta-analysis. *Thorax* 2022.
- Fancourt D, Steptoe A. Bu F.: Long-term psychological consequences of long Covid: a propensity score matching analysis comparing trajectories of depression and anxiety symptoms before and after contracting long Covid vs short Covid. *Medrxiv* 2022.
- Fernandez-de-Las-Penas C, Martin-Guerrero J. D. Cancela-Cilleruelo I. Moro-Lopez-Menchero P. Rodriguez-Jimenez J. Pellicer-Valero O. J.: Trajectory Curves of post-COVID Anxiety/Depressive Symptoms and Sleep Quality in Previously Hospitalized COVID-19 Survivors: the LONG-COVID-EXP-CM Multicenter Study. *Psychological medicine* 2022: 1–2.
- Fernandez-de-Las-Penas C, Martin-Guerrero J. D. Cancela-Cilleruelo I. Moro-Lopez-Menchero P. Rodriguez-Jimenez J. Navarro-Pardo E. Pellicer-Valero O. J.: Exploring the Recovery Curves for Long-term Post-COVID Functional Limitations on Daily Living Activities: the LONG-COVID-EXP-CM Multicenter Study. *Journal of infection* 2022; 84(5): 722–46.

- Fernandez-de-Las-Penas C, Martin-Guerrero J. D. Cancela-Cilleruelo I. Moro-Lopez-Menchero P. Rodriguez-Jimenez J. Pellicer-Valero O. J.: Exploring the Trajectory Recovery Curve of the number of Post-COVID Symptoms: the LONG-COVID-EXP-CM Multicenter Study. *International journal of infectious diseases* 2022; 117: 201–3.
- Fernandez-de-Las-Penas C, Martin-Guerrero J. D. Cancela-Cilleruelo I. Rodriguez-Jimenez J. Moro-Lopez-Menchero P. Pellicer-Valero O. J.: Exploring trajectory recovery curves of post-COVID cognitive symptoms in previously hospitalized COVID-19 survivors: the LONG-COVID-EXP-CM multicenter study. *Journal of neurology* 2022.
- Fernandez-de-Las-Penas C, Martin-Guerrero J. D. Navarro-Pardo E. Cancela-Cilleruelo I. Moro-Lopez-Menchero P. Pellicer-Valero O. J.: Exploring Trajectory Curves from Loss of Smell and Taste in Previously Hospitalized COVID-19 Survivors: the LONG-COVID-EXP-CM Multicenter Study. *Journal of general internal medicine* 2022; 37(7): 1821–3.
- Fernandez-De-las-Penas C, Martin-Guerrero J. D. Pellicer-Valero O. J. Navarro-Pardo E. Gomez-Mayordomo V. Cuadrado M. L. Arias-Navalon J. A. Cigaran-Mendez M. Hernandez-Barrera V. Arendt-Nielsen L.: Female Sex Is a Risk Factor Associated with Long-Term Post-COVID Related-Symptoms but Not with COVID-19 Symptoms: the LONG-COVID-EXP-CM Multicenter Study. *Journal of clinical medicine* 2022; 11(2).
- Fernandez-de-Las-Penas C, Navarro-Santana M, Plaza-Manzano G, Palacios-Cena D, Arendt-Nielsen L: Time course prevalence of post-COVID pain symptoms of musculoskeletal origin in patients who had survived severe acute respiratory syndrome coronavirus 2 infection: a systematic review and meta-analysis. *Pain* 2022; 163(7): 1220–31.
- Fernández-de-Las-Peñas C, Navarro-Santana M, Gómez-Mayordomo V, et al.: Headache as an acute and post COVID-19 Symptom in COVID-19 Survivors: A Meta-analysis of the Current Literature. *European journal of neurology* 2021.
- Fernandez-de-Las-Penas C, Palacios-Cena D, Gomez-Mayordomo V, et al.: Prevalence of post-COVID-19 symptoms in hospitalized and non-hospitalized COVID-19 survivors: A systematic review and meta-analysis. *Eur* 2021; 92: 55–70.
- Figueiredo EAB, Silva WT, Tsopanoglou SP, et al.: The health-related quality of life in patients with post-COVID-19 after hospitalization: a systematic review. *Rev Soc Bras Med Trop* 2022; 55: e0741.
- Fink EI, Robertson C. L. Wainwright M. S. Roa J. D. Lovett M. E. Stulce C. Yacoub M. Potera R. M. Zivick E. Holloway A. Nagpal A. Wellnitz K. Czech T. Even K. M. Brunow de Carvalho W. Rodriguez I. S. Schwartz S. P. Walker T. C. Campos-Mino S. Dervan L. A. Geneslaw A. S. Sewell T. B. Pryce P. Silver W. G. Lin J. E. Vargas W. S. Topjian A. Alcamo A. M. McGuire J. L. Dominguez Rojas J. A. Munoz J. T. Hong S. J. Muller W. J. Doerfler M. Williams C. N. Drury K. Bhagat D. Nelson A. Price D. Dapul H. Santos L. Kahoud R. Francoeur C. Appavu B. Guilliams K. P. Agner S. C. Walson K. H. Rasmussen L. Janas A. Ferrazzano P. Farias-Moeller R. Snooks K. C. Chang C. H. Yun J. Schober M. E. Global Consortium Study of Neurologic Dysfunction in Covid-Investigators: Prevalence and Risk Factors of Neurologic Manifestations in Hospitalized Children Diagnosed with Acute SARS-CoV-2 or MIS-C. *Pediatric neurology* 2022; 128: 33–44.
- Forster C, Colombo M. G. Wetzel A. J. Martus P. Joos S.: Persisting Symptoms After COVID-19. *Deutsches Arzteblatt international* 2022; 119(10): 167–74.
- Fortunato F, Martinelli D. Iannelli G. Milazzo M. Farina U. Di Matteo G. De Nittis R. Ascaticigno L. Cassano M. Lopalco P. L. Prato R.: Self-reported olfactory and gustatory dysfunctions in COVID-19 patients: a 1-year follow-up study in Foggia district, Italy. *BMC infectious diseases* 2022; 22(1): 77.
- Francis A, Harris J, Coleman J: Rehabilitation for Clients with Post COVID-19 Condition (Long COVID): Guidance for Canadian Rehabilitation and Exercise Professionals.

- Franke C, Berlit P, Pruss H: Neurological manifestations of post-COVID-19 syndrome S1-guideline of the German society of neurology. *Neurol* 2022; 4(1): 28.
- Frontera Ja, Simon N. M.: Bridging Knowledge Gaps in the Diagnosis and Management of Neuropsychiatric Sequelae of COVID-19. *JAMA psychiatry* 2022.
- Frosolini A, Parrino D, Fabbris C, et al.: Magnetic Resonance Imaging Confirmed Olfactory Bulb Reduction in Long COVID-19: Literature Review and Case Series. *Brain sciences* 2022; 12(4).
- Fugazzaro S, Contri A, Esseroukh O, et al.: Rehabilitation Interventions for Post-Acute COVID-19 Syndrome: A Systematic Review. *Int J Environ Res Public Health* 2022; 19(9).
- Funke-Chambour M, Bridevaux PO, Clarenbach CF, et al.: Swiss Recommendations for the Follow-Up and Treatment of Pulmonary Long COVID. *Respiration* 2021; 100(8): 826–41.
- Gebhard C E, Suetsch C. Bengs S. Todorov A. Deforth M. Buehler K. P. Meisel A. Schuepbach R. A. Zinkernagel A. S. Brugger S. D. Acevedo C. Patriki D. Wiggli B. Gysi B. Beer J. H. Friedl A. Twerenbold R. Kuster G. M. Pargger H. Tschudin-Sutter S. Schefold J. C. Spinetti T. Henze C. Pasqualini M. Sager D. F. Mayrhofer L. Grieder M. C. Tontsch J. Franzeck F. Wendel Garcia P. D. Hofmaenner D. A. Scheier T. Bartussek J. Haider A. Graemer M. Mikail N. Rossi A. Zellweger N. Opic P. Portmann A. von Kanel R. Pazhenkotti: Understanding the Impact of Sociocultural Gender on Post-acute Sequelae of COVID-19: a Bayesian Approach. *Medrxiv* 2022: 2021.06.30.21259757.
- Gentile A, Juarez M. D. V. Romero Bollon L. Cancellara A. D. Pasinovich M. Brizuela M. Euliarte C. Ensinck G. N. Russ C. Saraceni L. Tapponier G. Villa Nova S. Falaschi A. Garnerio A. Melonari P. Bellone L. Gaiano A. Pebe Florian V. Bogdanowicz E. Areso M. S. Red de Pediatria Covid: A multicenter study of confirmed COVID-19 cases: preliminary data on 2690 pediatric patients in Argentina during the first year of the pandemic. *Archivos argentinos de pediatria* 2022; 120(2): 80–8.
- Godfred-Cato S, Abrams J. Y. Balachandran N. Jaggi P. Jones K. Rostad C. A. Lu A. T. Fan L. Jabbar A. Anderson E. J. Kao C. M. Hunstad D. A. Rosenberg R. B. Zafferani M. J. Ede K. C. Ballan W. Laham F. R. Beltran Y. Bryant B. Meng L. Hammett T. A. Oster M. E. Bamrah Morris S. Belay E. D.: Distinguishing Multisystem Inflammatory Syndrome in Children From COVID-19, Kawasaki Disease and Toxic Shock Syndrome. *Pediatric infectious disease journal* 2022; 41(4): 315–23.
- Gonzalez-Andrade F: Post-COVID-19 conditions in Ecuadorian patients: an observational study. *Lancet regional health. Americas* 2022; 5: 100088.
- Gonzalez-Dambrauskas S, Vasquez-Hoyos P. Camporesi A. Cantillano E. M. Dallefeld S. Dominguez-Rojas J. Francoeur C. Gurbanov A. Mazzillo-Vega L. Shein S. L. Yock-Corrales A. Karsies T. Critical Coronavirus, Kids Epidemiological Study I: Paediatric critical COVID-19 and mortality in a multinational prospective cohort. *Lancet regional health. Americas* 2022; 12: 100272.
- Goodwin VA, Allan L, Bethel A, et al.: Rehabilitation to enable recovery from COVID-19: a rapid systematic review. *Physiotherapy* 2021; 111: 4–22.
- Gu X, Huang L. Cui D. Wang Y. Wang Y. Xu J. Shang L. Fan G. Cao B.: Association of acute kidney injury with 1-year outcome of kidney function in hospital survivors with COVID-19: a cohort study. *EBioMedicine* 2022; 76: 103817.
- Gupta M, Gupta N, Esang M: Long COVID in Children and Adolescents. *Prim Care Companion CNS Disord* 2022; 24(2): 26.

- Halabchi F, Selk-Ghaffari M, Tazesh B, Mahdaviani B: The effect of exercise rehabilitation on COVID-19 outcomes: a systematic review of observational and intervention studies. *Sport sciences for health* 2022; 1–19.
- Haller J, Kocalevent R. D. Nienhaus A. Peters C. Bergelt C. Koch-Gromus U.: Persistent fatigue symptoms following COVID-19 infection in healthcare workers: risk factors and impact on quality of life. *Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz* 2022; 65(4): 471–80.
- Hama Amin BJ, Kakamad FH, Ahmed GS, et al.: Post COVID-19 pulmonary fibrosis; a meta-analysis study. *Ann Med Surg (Lond)* 2022; 77: 103590.
- Han Jh, Womack K. N. Tenforde M. W. Files D. C. Gibbs K. W. Shapiro N. I. Prekker M. E. Erickson H. L. Steingrub J. S. Qadir N. Khan A. Hough C. L. Johnson N. J. Ely E. W. Rice T. W. Casey J. D. Lindsell C. J. Gong M. N. Srinivasan V. Lewis N. M. Patel M. M. Self W. H. Influenza, Other Viruses in the Acutely Ill, Network: Associations between persistent symptoms after mild COVID-19 and long-term health status, quality of life, and psychological distress. *Influenza and other respiratory viruses* 2022.
- Han Q, Zheng B, Daines L, Sheikh A: Long-Term Sequelae of COVID-19: A Systematic Review and Meta-Analysis of One-Year Follow-Up Studies on Post-COVID Symptoms. *Pathogens* 2022; 11(2): 19.
- Harthan A, Nadiger M. McGarvey J. S. Hanson K. Gharpure V. P. Bjornstad E. C. Chitotos K. Miller A. S. Reikoff R. A. Gajic O. Kumar V. Walkey A. Kashyap R. Tripathi S. Covid-Registry Investigator Group: Early combination therapy with immunoglobulin and steroids is associated with shorter ICU length of stay in Multisystem Inflammatory Syndrome in Children (MIS-C) associated with COVID19: a retrospective cohort analysis from 28 U.S Hospitals. *Pharmacotherapy* 2022.
- Hauptert S R, Shi X. Chen C. Fritsche L. G. Mukherjee B.: A Case-Crossover Phenome-wide Association Study (PheWAS) for Understanding Post-COVID-19 Diagnosis Patterns. *Medrxiv* 2022.
- Hawke LD, Nguyen ATP, Ski CF, Thompson DR, Ma C, Castle D: Interventions for mental health, cognition, and psychological wellbeing in long COVID: a systematic review of registered trials. *Psychol Med* 2022; 1–15.
- Hawkins J, Hires C. Keenan L. Dunne E.: Aromatherapy Blend of Thyme, Orange, Clove Bud, and Frankincense Boosts Energy Levels in Post-COVID-19 Female Patients: a Randomized, Double-Blinded, Placebo Controlled Clinical Trial. *Complementary therapies in medicine* 2022; 67: 102823.
- Hayes LD, Ingram J, Sculthorpe NF: More Than 100 Persistent Symptoms of SARS-CoV-2 (Long COVID): A Scoping Review. *Front Med (Lausanne)* 2021; 8: 750378.
- Hazan G, Shah M. Z. Brennan S.: Markers for severe disease and long-term sequelae in pediatric patients with severe acute respiratory syndrome coronavirus 2 infection. *Pediatrics international* 2022; 64(1): e15177.
- Healey Q, Sheikh A, Daines L, Vasileiou E: Symptoms and signs of long COVID: A rapid review and meta-analysis. *J* 2022; 12: 5014.
- Heightman M, Prashar J, Hillman TE, et al.: Correction: post-COVID-19 assessment in a specialist clinical service: a 12-month, single-centre, prospective study in 1325 individuals. *BMJ open respiratory research* 2022; 9(1).
- Heiss R, Wagner A. L. Tan L. Schmidt S. Regensburger A. P. Ewert F. Mammadova D. Buehler A. Vogel-Claussen J. Voskrebenezv A. Rompel O. Nagel A. M. Levy S. Bickelhaupt S. May M. S. Uder M. Metzler M. Trollmann R. Woelfle J. Knieling F.: Persisting pulmonary dysfunction in pediatric post-acute Covid-19. *Medrxiv* 2022.

- Henderson LA, Canna SW, Friedman KG, et al.: American College of Rheumatology Clinical Guidance for Multisystem Inflammatory Syndrome in Children Associated With SARS-CoV-2 and Hyperinflammation in Pediatric COVID-19: Version 2. *Arthritis rheumatol* 2021; 73(4): e13-e29.
- Himmels JPW, Qureshi SA, Brurberg KG, Gravningen KM: COVID-19: Long-Term Effects of COVID-19 2021.
- Hiroshi H, Takahiro M, Hiroyuki S, Shunsuke H, Norifumi K, Toshiya S: Incidence of Long-term Post-acute Sequelae of SARS-CoV-2 Infection Related to Pain and Other Symptoms: A Living Systematic Review and Meta-analysis. *Medrxiv* 2021.
- Hoste L, Soriano-Arandes A, Buddingh E, P. Whittaker E, Belot A, Ulloa-Gutierrez R, Olbrich P, Haerynck F.: SARS-CoV-2 vaccination in children with a history of MIS-C: an international survey. *Journal of pediatrics* 2022.
- Huang L, Li X, Gu X, Zhang H, Ren L, Guo L, Liu M, Wang Y, Cui D, Wang Y, Zhang X, Shang L, Zhong J, Wang X, Wang J, Cao B.: Health outcomes in people 2 years after surviving hospitalisation with COVID-19: a longitudinal cohort study. *Lancet respiratory medicine* 2022.
- Iqbal FM, Lam K, Sounderajah V, Clarke JM, Ashrafian H, Darzi A: Characteristics and predictors of acute and chronic post-COVID syndrome: A systematic review and meta-analysis. *EClinicalMedicine* 2021; 36: 100899.
- Iwu CJ, Iwu CD, Wiysonge CS: The occurrence of long COVID: a rapid review. *Pan Afr Med J* 2021; 38: 65.
- Izquierdo-Pujol J, Moron-Lopez S, Dalmau J, et al.: Post COVID-19 Condition in Children and Adolescents: An Emerging Problem. *Frontiers in pediatrics* 2022; 10: 894204.
- Jain Pn, Acosta S, Annapragada A, Checchia P, A. Moreira A, Muscal E, Sartain S, E. Tejtel S, K. S. Vogel T, P. Shekerdemian L, Rusin C, G.: Comparison of Laboratory and Hemodynamic Time Series Data Across Original, Alpha, and Delta Variants in Patients With Multisystem Inflammatory Syndrome in Children. *Pediatric critical care medicine* 2022.
- Jennifer P, Sholeh R, Samantha G, Aireen W, Lisa H: Risk factors and preventive interventions for post Covid-19 condition: systematic reviews. *Medrxiv* 2022.
- Jennings G, Monaghan A, Xue F, Mockler D, Romero-Ortuno R: A Systematic Review of Persistent Symptoms and Residual Abnormal Functioning following Acute COVID-19: Ongoing Symptomatic Phase vs. Post-COVID-19 Syndrome. *J* 2021; 10(24): 16.
- Ji G, Chen C, Zhou M, et al.: Post-COVID-19 fatigue among COVID-19 in patients discharged from hospital: A meta-analysis. *J Infect* 2022; 84(5): 722–46.
- Chandan JS, Brown K, Simms-Williams N, et al.: Non-pharmacological therapies for post-viral syndromes, including Long COVID: a systematic review and meta-analysis protocol. *BMJ Open* 2022; 12(4): e057885.
- Joshee S, Vatti N, Chang C: Long-Term Effects of COVID-19. *Mayo Clin Proc* 2022; 97(3): 579–99.
- Julian H, Perrine J, Viktoria G, et al.: Validity of reported post-acute health outcomes in children with SARS-CoV-2 infection: a systematic review. *Medrxiv* 2022.
- Junior G, Siqueira L, Loro L, et al.: Neurologic and neuropsychiatric symptoms in long-COVID 19 syndrome: a systematic review. *ResearchSquare* 2022.
- Kalin S SB: Radiological findings of multisystem inflammatory syndrome in children associated with COVID-19. *British journal of radiology* 2022: 20220101.
- Karagiannidis C, Sander L, E. Mall M, A. Busse R.: Incidence and outcomes of SARS-CoV-2-associated PIMS in Germany: a nationwide analysis. *Infection* 2022.

- Karosanidze I, Kiladze U. Kirtadze N. Giorgadze M. Amashukeli N. Parulava N. Iluridze N. Kikabidze N. Gudavadze N. Gelashvili L. Koberidze V. Gigashvili E. Jajanidze N. Latsabidze N. Mamageishvili N. Shengelia R. Hovhannisyan A. Panossian A.: Efficacy of Adaptogens in Patients with Long COVID-19: a Randomized, Quadruple-Blind, Placebo-Controlled Trial. *Pharmaceuticals (Basel, Switzerland)* 2022; 15(3).
- Kendall E, Olaker V. Kaelber D. C. Xu R. Davis P. B.: Elevated liver enzymes and bilirubin following SARS-CoV-2 infection in children under 10. *Medrxiv* 2022.
- Kharaeva Z, Shokarova A. Shomakhova Z. Ibragimova G. Trakhtman P. Trakhtman I. Chung J. Mayer W. De Luca C. Korkina L.: Fermented *Carica papaya* and *Morinda citrifolia* as Perspective Food Supplements for the Treatment of Post-COVID Symptoms: randomized Placebo-Controlled Clinical Laboratory Study. *Nutrients* 2022; 14(11).
- Khoja O, Silva Passadouro B, Mulvey M, et al.: Clinical Characteristics and Mechanisms of Musculoskeletal Pain in Long COVID. *J Pain Res* 2022; 15: 1729–48.
- Khraisat B, Toubasi A, AlZoubi L, Al-Sayegh T, Mansour A: Meta-analysis of prevalence: the psychological sequelae among COVID-19 survivors. *Int* 2021: 1–10.
- Kikkenborg Berg S, Dam Nielsen S. Nygaard U. Bundgaard H. Palm P. Rotvig C. Vinggaard Christensen A.: Long COVID symptoms in SARS-CoV-2-positive adolescents and matched controls (LongCOVIDKidsDK): a national, cross-sectional study. *The lancet. Child & adolescent health* 2022; 6(4): 240–8.
- Kikkenborg Berg S, Palm P. Nygaard U. Bundgaard H. Petersen M. N. S. Rosenkilde S. Thorsted A. B. Ersbøll A. K. Thygesen L. C. Nielsen S. D. Vinggaard Christensen A.: Long COVID symptoms in SARS-CoV-2-positive children aged 0-14 years and matched controls in Denmark (LongCOVIDKidsDK): a national, cross-sectional study. *The lancet. Child & adolescent health* 2022.
- Kildegaard H, Lund L. C. Højlund M. Stensballe L. G. Pottegard A.: Risk of adverse events after covid-19 in Danish children and adolescents and effectiveness of BNT162b2 in adolescents: cohort study. *BMJ (Clinical research ed.)* 2022; 377: e068898.
- King, Meredith Byrne Anthony Denehy Linda Graham Petra Douglas Ben de Toni Priscilla Santos Angelo Kitson Emily Pang Alison Bartos Elena Plit Marshall Mungovan Sean: Feasibility of a Group-Based Telerehabilitation Intervention for Long COVID Management (preprint) 2022/00. doi:10.21203/rs.3.rs-1452186/v1.
- Kiss A, Ryan PM, Mondal T: Management of COVID-19-associated multisystem inflammatory syndrome in children: A comprehensive literature review. *Prog Pediatr Cardiol* 2021; 63: 101381.
- Knoke L, Schlegte A. Maier C. Eitner L. Lucke T. Brinkmann F.: Pulmonary Function and Long-Term Respiratory Symptoms in Children and Adolescents After COVID-19. *Frontiers in pediatrics* 2022; 10: 851008.
- Koczulla AR, Ankermann T, Behrends U, et al.: [S1 Guideline "Post-COVID/Long-COVID"]. *Chirurg* 2022; 93(1): 101–2.
- Kostev K, Smith L. Koyanagi A. Konrad M. Jacob L.: Post-COVID-19 conditions in children and adolescents diagnosed with COVID-19. *Pediatric research* 2022.
- Kostik Mm, Bregel L. V. Avrusin I. S. Efremova O. S. Belozarov K. E. Dondurei E. A. Kornishina T. L. Isupova E. A. Abramova N. N. Felker E. Y. Masalova V. V. Santimov A. V. Kozlov Y. A. Barakin A. O. Snegireva L. S. Konstantinova J. Vilnits A. A. Bekhtereva M. K. Argunova V. M. Matyunova A. E. Sleptsova P. A. Burtseva T. E. Shprakh V. V. Boyko T. V. Kalashnikova O. V. Chasnyk V. G.: Heart Involvement in Multisystem Inflammatory Syndrome, Associated With COVID-19 in Children: the Retrospective Multicenter Cohort Data. *Frontiers in pediatrics* 2022; 10: 829420.

- Kuodi P, Gorelik Y, Zayyad H, Wertheim O, Beiruti Wiegler K, Abu Jabal K, Dror A, Nazzal S, Glikman D, Edelstein M.: Association between vaccination status and reported incidence of post-acute COVID-19 symptoms in Israel: a cross-sectional study of patients tested between March 2020 and November 2021. *Medrxiv* 2022.
- Kurtais Aytur Y, Fusun Koseoglu B, Ozyemisci Taskiran O, et al.: Pulmonary rehabilitation principles in SARS-COV-2 infection (COVID-19): The revised guideline for the acute, subacute, and post-COVID-19 rehabilitation. *Turk J Phys Med Rehabil* 2021; 67(2): 129–45.
- La Stadio A DLVLACEDLPCCMGDRGVFSGDVMCAMIFFBMJ: Ultramicronized Palmitoylethanolamide and Luteolin Supplement Combined with Olfactory Training to Treat Post-COVID-19 Olfactory Impairment: a Multi-Center Double-Blinded Randomized Placebo-Controlled Clinical Trial. *Current neuropharmacology* 2022.
- Lapp Sa, Abrams J, Lu A. T, Hussaini L, Kao C. M, Hunstad D. A, Rosenberg R. B, Zafarani M. J, Ede K. C, Ballan W, Laham F. R, Beltran Y, Hsiao H. M, Sherry W, Jenkins E, Jones K, Horner A, Brooks A, Bryant B, Meng L, Hammett T. A, Oster M. E, Bamrah-Morris S, Godfred-Cato S, Belay E, Chahroudi A, Anderson E. J, Jaggi P, Rostad C. A.: Serologic and Cytokine Signatures in Children With Multisystem Inflammatory Syndrome and Coronavirus Disease 2019. *Open forum infectious diseases* 2022; 9(3): ofac070.
- Larsen N W, Stiles L. E, Shaik R, Schneider L, Muppidi S, Tsui C. T, Miglis M. G.: Characterization of Autonomic Symptom Burden in Long COVID: a Global Survey of 2,314 Adults. *Medrxiv* 2022.
- Lasa Jj, Alali A, Anders M, Tume S. C, Muscal E, Tejtet S. K. S, Shekerdeman L.: Cardiovascular sequelae from COVID-19: perspectives from a paediatric cardiac ICU. *Cardiology in the young* 2022: 1–8.
- Lee J, Yim J, Park J: Impaired Diffusion Capacity and Pulmonary Fibrosis after Recovery from COVID-19: A Systematic Review and Meta-Analysis. *ResearchSquare* 2021.
- Lemes IR, Smaira FI, Ribeiro WJD, et al.: Acute and post-acute COVID-19 presentations in athletes: a systematic review and meta-analysis. *BJSM online* 2022; 27: 27.
- Leung TYM, Chan AYL, Chan EW, et al.: Short- and potential long-term adverse health outcomes of COVID-19: a rapid review. *Emerging microbes & infections* 2020; 9(1): 2190–9.
- Levy N, Koppel J. H, Kaplan O, Yechiam H, Shahar-Nissan K, Cohen N. K, Shavit I.: Severity and Incidence of Multisystem Inflammatory Syndrome in Children During 3 SARS-CoV-2 Pandemic Waves in Israel 2022.
- Long Q, Li J, Hu X, Bai Y, Zheng Y, Gao Z: Follow-Ups on Persistent Symptoms and Pulmonary Function Among Post-Acute COVID-19 Patients: A Systematic Review and Meta-Analysis. *Front Med (Lausanne)* 2021; 8: 702635.
- Loosen Sh, Jensen B. O, Tanislav C, Luedde T, Roderburg C, Kostev K.: Obesity and lipid metabolism disorders determine the risk for development of long COVID syndrome: a cross-sectional study from 50,402 COVID-19 patients. *Infection* 2022.
- Lopez-Leon S, Wegman-Ostrosky T, Perelman C, et al.: More Than 50 Long-Term Effects of COVID-19: A Systematic Review and Meta-Analysis. *Preprint. Res Sq* 2021.
- Lopez-Leon S, Wegman-Ostrosky T, Ayuzo Del Valle, N. C., et al.: Long-COVID in children and adolescents: a systematic review and meta-analyses. *Sci* 2022; 12(1): 9950.
- Luca P de, Di Stadio A, Colacurcio V, et al.: Long COVID, audiovestibular symptoms and persistent chemosensory dysfunction: a systematic review of the current evidence. *Acta Otorhinolaryngol Ital* 2022; 42(Suppl. 1): S87-S93.

- Ma Y, Deng J, Liu Q, Du M, Liu M, Liu J: Long-Term Consequences of COVID-19 at 6 Months and Above: A Systematic Review and Meta-Analysis. *Int J Environ Res Public Health* 2022; 19(11): 3.
- Macpherson K, Cooper K, Harbour J, Mahal D, Miller C, Nairn M: Experiences of living with long COVID and of accessing healthcare services: a qualitative systematic review. *BMJ Open* 2022; 12(1): e050979.
- Madaan S, Talwar D, Jaiswal A, et al.: Post-COVID-19 menstrual abnormalities and infertility: Repercussions of the pandemic. *J* 2022; 11: 170.
- Maddux Ab, Berbert L. Young C. C. Feldstein L. R. Zambrano L. D. Kucukak S. Newhams M. M. Miller K. FitzGerald M. M. He J. Halasa N. B. Cvijanovich N. Z. Loftis L. L. Walker T. C. Schwartz S. P. Gertz S. J. Tarquinio K. M. Fitzgerald J. C. Kong M. Schuster J. E. Mack E. H. Hobbs C. V. Rowan C. M. Staat M. A. Zinter M. S. Irby K. Crandall H. Flori H. Cullimore M. L. Nofziger R. A. Shein S. L. Gaspers M. G. Hume J. R. Levy E. R. Chen S. R. Patel M. M. Tenforde M. W. Weller E. Campbell A. P. Randolph A. G.: Health Impairments in Children and Adolescents After Hospitalization for Acute COVID-19 or MIS-C. *Pediatrics* 2022.
- Maglietta G, Diodati F, Puntoni M, et al.: Prognostic Factors for Post-COVID-19 Syndrome: A Systematic Review and Meta-Analysis. *J* 2022; 11(6): 11.
- Magnúsdóttir I, Lovik A, Unnarsdóttir AB, et al.: Acute COVID-19 severity and mental health morbidity trajectories in patient populations of six nations: an observational study. *The Lancet Public Health* 2022; 7(5): e406-e416.
- Magnusson K, Kristoffersen D. T. Dell'Isola A. Kiadaliri A. Turkiewicz A. Runhaar J. Bierma-Zeinstra S. Englund M. Magnus P. M. Kinge J. M.: Post-covid medical complaints after SARS-CoV-2 Omicron vs Delta variants -a prospective cohort study. *Medrxiv* 2022.
- Mainous Ag, Rooks B. J. Orlando F. A.: The Impact of Initial COVID-19 Episode Inflammation Among Adults on Mortality Within 12 Months Post-hospital Discharge. *Frontiers in medicine* 2022; 9: 891375.
- Malik P, Patel K, Pinto C, et al.: Post-acute COVID-19 syndrome (PCS) and Health related Quality of life (HRQoL)- A systematic review and Meta-analysis. *Journal of medical virology* 2021.
- Mariani C, Borgonovo F. Capetti A. F. Oreni L. Cossu M. V. Pellicciotta M. Armiento L. Bocchio S. Dedivitiis G. Lupo A. Galli M. Rizzardini G.: Persistence of Long-COVID symptoms in a heterogenous prospective cohort. *Journal of infection* 2022; 84(5): 722–46.
- Martin B, DeWitt P. E. Russell S. Anand A. Bradwell K. R. Bremer C. Gabriel D. Girvin A. T. Hajagos J. G. McMurry J. A. Neumann A. J. Pfaff E. R. Walden A. Wooldridge J. T. Yoo Y. J. Saltz J. Gersing K. R. Chute C. G. Haendel M. A. Moffitt R. Bennett T. D.: Characteristics, Outcomes, and Severity Risk Factors Associated With SARS-CoV-2 Infection Among Children in the US National COVID Cohort Collaborative. *JAMA network open* 2022; 5(2): e2143151.
- Massey D, Saydah S. Adamson B. Lincoln A. Aukerman D. Berke E. Sikka R. Krumholz H.: Prevalence of COVID-19 and Long COVID in Collegiate Student Athletes from Spring 2020 to Fall 2021: a Retrospective Survey. *Medrxiv* 2022.
- McNarry Ma, Berg R. M. G. Shelley J. Hudson J. Saynor Z. L. Duckers J. Lewis K. Davies G. A. Mackintosh K. A.: Inspiratory Muscle Training Enhances Recovery Post COVID-19: a Randomised Controlled Trial. *The european respiratory journal* 2022.
- Mejias A, Schuchard J. Rao S. Bennett T. D. Jhaveri R. Thacker D. Bailey C. C. Christakis D. Pajor N. Razzaghi H. Forrest C. B. Lee G. M.: Leveraging serology testing

to identify children at risk for post-acute sequelae of SARS-CoV-2 infection: an EHR-based cohort study from the RECOVER program. *Medrxiv* 2022.

- Melgar M, Haston J. DeCuir J. Cheng Q. Arnold K. E. Meng L. Murphy D. J. Overton E. Hollberg J. Tobin-D'Angelo M. Patel P. Campbell A. P. Godfred-Cato D. O. S. Belay E. D.: Multisystem inflammatory syndrome in adults (MIS-A): case finding through systematic review of electronic medical records. *Clinical infectious diseases* 2022.
- Mendelsohn As, Nath N. De Sa A. Von Pressentin K. B.: Two months follow-up of patients with non-critical COVID-19 in Cape Town, South Africa. *South African family practice* 2022; 64(1): e1-e6.
- Merckx J, Cooke S. El Tal T. Bitnun A. Morris S. K. Yeh E. A. Yea C. Gill P. Papenburg J. Lefebvre M. A. Scuccimarri R. Ulloa-Gutierrez R. Brenes-Chacon H. Yock-Corrales A. Ivankovich-Escoto G. Soriano-Fallas A. Mezerville M. H. Dewan T. Restivo L. Nateghian A. Aski B. H. Manafi A. Dwilow R. Bullard J. Lopez A. Sadarangani M. Roberts A. Barton M. Petel D. Le Saux N. Bowes J. Purewal R. Lautermilch J. Tehseen S. Bayliss A. Wong J. K. Leifso K. Foo C. Robinson J. Pediatric Investigators Collaborative Network on Infections in Canada: Predictors of severe illness in children with multisystem inflammatory syndrome after SARS-CoV-2 infection: a multicentre cohort study. *CMAJ Canadian Medical Association journal* 2022; 194(14): E513-E523.
- Merzon E, Weiss M. Krone B. Cohen S. Ilani G. Vinker S. Cohen-Golan A. Green I. Israel A. Schneider T. Ashkenazi S. Weizman A. Manor I.: Clinical and Socio-Demographic Variables Associated with the Diagnosis of Long COVID Syndrome in Youth: a Population-Based Study. *International journal of environmental research and public health* 2022; 19(10).
- Meyer PT, Hellwig S, Blazhenets G, Hosp JA: Molecular Imaging Findings on Acute and Long-Term Effects of COVID-19 on the Brain: A Systematic Review. *J Nucl Med* 2022; 63(7): 971–80.
- Meza-Torres B, Delanerolle G. Okusi C. Mayer N. Anand S. McCartney J. Gatenby P. Glampson B. Chapman M. Curcin V. Mayer E. Joy M. Greenhalgh T. Delaney B. de Lusignan S.: Differences in clinical presentation with long covid following community and hospital infection, and associations with all-cause mortality: english sentinel network database study. *JMIR public health and surveillance* 2022.
- Michelen M, Manoharan L, Elkheir N, et al.: Characterising long COVID: a living systematic review. *BMJ glob* 2021; 6(9): 9.
- Micheletto C, Izquierdo JL, Avdeev SN, Rada Escobar RA, Pacheco Gallego MC: N-acetylcysteine as a therapeutic approach to post-COVID-19 pulmonary fibrosis adjunctive treatment. *Eur Rev Med Pharmacol Sci* 2022; 26(13): 4872–80.
- Miller Ad, Yousaf A. R. Bornstein E. Wu M. J. Lindsey K. Melgar M. Oster M. E. Zambrano L. D. Campbell A. P.: Multisystem Inflammatory Syndrome in Children (MIS-C) During SARS-CoV-2 Delta and Omicron Variant Circulation- United States, July 2021 - January 2022. *Clinical infectious diseases* 2022.
- Mukherjee PK, Efferth T, Das B, et al.: Role of medicinal plants in inhibiting SARS-CoV-2 and in the management of post-COVID-19 complications. *Phytomedicine* 2022; 98: 153930.
- Murch Bj, Hollier S. E. Kenward C. Wood R. M.: Use of linked patient data to assess the effect of Long-COVID on system-wide healthcare utilisation. *Health information management* 2022: 18333583221089915.
- Nandasena H, Pathirathna ML, Atapattu A, Prasanga PTS: Quality of life of COVID 19 patients after discharge: Systematic review. *PloS one* 2022; 17(2): e0263941.

- Nehme M, Braillard O, Chappuis F, Courvoisier D, S. Kaiser L, Soccal P, M. Reny J, L. Assal F, Bondolfi G, Tardin A, Graf C, Zekry D, Stringhini S, Spechbach H, Jacqueroz F, Salamun J, Lador F, Coen M, Agoritsas T, Benzakour L, Favale R, Genevay S, Lauper K, Meyer P, Poku N, K. Landis B, N. Baggio S, Grira M, Sandoval J, Ehram J, Regard S, Genecand C, Kopp G, Guerreiro I, Allali G, Vetter P, Guessous I. CoviCare Study Team: One-year persistent symptoms and functional impairment in SARS-CoV-2 positive and negative individuals. *Journal of internal medicine* 2022.
- Nguyen NN, van Hoang T, Dao TL, Dudouet P, Eldin C, Gautret P: Clinical patterns of somatic symptoms in patients suffering from post-acute long COVID: a systematic review. *Eur J Clin Microbiol Infect Dis* 2022; 41(4): 515–45.
- Nguyen Nn Hoang V. T. Dao T. L. Meddeb L. Cortaredona S., Lagier J. C. Million M. Raoult D. Gautret P.: Long-Term Persistence of Olfactory and Gustatory Disorders in COVID-19 Patients. *Frontiers in medicine* 2022; 9: 794550.
- NICE National Institute for Health and Care Excellence: Overview | COVID-19 rapid guideline: managing the long-term effects of COVID-19. <https://www.nice.org.uk/guidance/ng188> (last accessed on 21 June 2022)
- Nittas V, Gao M, West EA, et al.: Long COVID Through a Public Health Lens: An Umbrella Review. *Public Health Rev* 2022; 43: 1604501.
- Nugawela M, Stephenson T, Shafran R, De Stavola B, L. Ladhani S, Simmons R, McOwatt K, Rojas N, Cheung E, Y. Ford T, Heyman I, Crawley E, Pinto Pereira S, M.: Developing a model for predicting impairing physical symptoms in children 3 months after a SARS-CoV-2 PCR-test: the CLoCk Study. *Medrxiv* 2022.
- O'Byrne L, Webster KE, MacKeith S, Philpott C, Hopkins C, Burton MJ: Interventions for the treatment of persistent post-COVID-19 olfactory dysfunction. *Cochrane Database Syst Rev* 2021; 7: CD013876.
- Odozor Cu, Kannampallil T, Ben Abdallah A, Roles K, Burk C, Warner B, C. Alaverdyan H, Clifford D, B. Piccirillo J, F. Haroutounian S.: Post-acute sensory neurological sequelae in patients with severe acute respiratory syndrome coronavirus 2 infection: the COVID-PN observational cohort study. *Pain* 2022.
- Ohla K, Veldhuizen M. G. Green T, Hannum M, E. Bakke A, J. Moein S, T. Tognetti A, Postma E, M. Pellegrino R, Hwang D, L. D. Albayay J, Koyama S, Nolden A, A. Thomas-Danguin T, Mucignat-Caretta C, Menger N, S. Croijmans I, Ozturk L, Yanik H, Pierron D, Pereda-Loth V, Nunez-Parra A, Martinez Pineda A, M. Gillespie D, Farruggia M, C. Cecchetto C, Fornazieri M, A. Philpott C, Voznessenskaya V, Cooper K, W. Rohlf's Dominguez P, Calcinoni O, de Groot J, Boesveldt S, Bhutani S, Weir E, M. Exten C, Joseph P, V. Hayes J, E. Niv M, Y.: A follow-up on quantitative and qualitative olfactory dysfunction and other symptoms in patients recovering from COVID-19 smell loss. *Rhinology* 2022.
- Okan F, Okan S, Duran Yucesoy F.: Evaluating the Efficiency of Breathing Exercises via Telemedicine in Post-Covid-19 Patients: randomized Controlled Study. *Clinical nursing research* 2022; 31(5): 771–81.
- Oliveira Almeida K de, Nogueira Alves IG, Queiroz RS de, et al.: A systematic review on physical function, activities of daily living and health-related quality of life in COVID-19 survivors. *Chronic illness* 2022: 17423953221089309.
- Oyungerel B, Paulina S, Justin C, Kylie A, Paul G: Impact of COVID-19 vaccination on long COVID: a systematic review and meta-analysis. *Medrxiv* 2022.
- Ozlu A, Yaman F, Leblebici MA, Ozkaya DB: Efficacy of a home exercise program on balance, kinesiophobia, pain and quality of life in post-COVID-19 patients Efficacy of a

home exercise program in post COVID. *Annals of Clinical and Analytical Medicine* 2022; 13(5): 563–7.

- Ozturk S, Turgutalp K. Arici M. Gorgulu N. Tonbul H. Z. Eren N. Gencer V. Ayli M. D. Pembegul I. Dolarslan M. E. Ural Z. Colak H. Ozler T. E. Can O. Demir M. E. Altunoren O. Huddam B. Onec K. Demirelli B. Aydin Z. Altun E. Alagoz S. Ayar Y. Eser Z. E. Bertkas B. Yilmaz Z. Ates E. U. Yuksel E. Sahin G. K. Aktar M. Cebeci E. Dursun B. Kocak S. Y. Yildiz A. Kazan S. Gok M. Sengul E. Tugcu M. Ozturk R. Kahvecioglu S. Kara E. Kaya B. Sahin G. Sakaci T. Sipahi S. Kurultak I. Durak B. A. Altiparmak M. R. Ecder S. A. Karadag S. Dincer M. T. Ozer H. Bek S. G. Ulu M. S. Gungor O. Bakir E. A. Odabas A. R. Seyahi N. Yildiz A. Ates K.: The Longitudinal Evolution of Post-COVID-19 Outcomes Among Hemodialysis Patients in Turkey. *Kidney international reports* 2022; 7(6): 1393–405.
- Pajor N M, Lorman V. Razzaghi H. Case A. Prahalad P. Bose-Brill S. Wu Q. Chen Y. Block J. P. Patel P. B. Rao S. Mejias A. Thacker D. Jhaveri R. Bailey L. C. Forrest C. B. Lee G. M.: Healthcare utilization following SARS-CoV-2 infection in children and adolescents with chronic conditions: an EHR-based Cohort Study from the RECOVER Program. *Medrxiv* 2022.
- Palacios S, Krivchenia K. Eisner M. Young B. Ramilo O. Mejias A. Lee S. Kopp B. T.: Long-term pulmonary sequelae in adolescents post-SARS-CoV-2 infection. *Pediatric pulmonology* 2022.
- Pang W, Yang F. Zhao Y. Dai E. Feng J. Huang Y. Guo Y. Zhou S. Huang M. Zheng W. Ma J. Li H. Li Q. Hou L. Zhang S. Wang H. Liu Q. Zhang B. Zhang J.: Qingjin Yiqi granules for post-COVID-19 condition: a randomized clinical trial. *Journal of evidence-based medicine* 2022; 15(1): 30–8.
- Patel N, Dahman B. Bajaj J. S.: Development of New Mental and Physical Health Sequelae among US Veterans after COVID-19. *Journal of clinical medicine* 2022; 11(12).
- Patel T, Kelleman M. West Z. Peter A. Dove M. Butto A. Oster M. E.: Comparison of Multisystem Inflammatory Syndrome in Children-Related Myocarditis, Classic Viral Myocarditis, and COVID-19 Vaccine-Related Myocarditis in Children. *Journal of the American Heart Association* 2022; 11(9): e024393.
- Paterson I, Ramanathan K, Aurora R, et al.: Long COVID-19: A Primer for Cardiovascular Health Professionals, on Behalf of the CCS Rapid Response Team. *Can J Cardiol* 2021; 37(8): 1260–2.
- Patrucco F, Zeppegno P, Baricich A, et al.: Long-lasting consequences of coronavirus disease 19 pneumonia: a systematic review. *Minerva Med* 2022; 113(1): 158–71.
- Pazukhina E, Andreeva M. Spiridonova E. Bobkova P. Shikhaleva A. El-Taravi Y. Rumyantsev M. Gamirova A. Bairashevskaja A. Petrova P. Baimukhambetova D. Pikuza M. Abdeeva E. Filippova Y. Deunezhewa S. Nekliudov N. Bugaeva P. Bulanov N. Avdeev S. Kapustina V. Guekht A. DunnGalvin A. Comberati P. Peroni D. G. Apfelbacher C. Genuneit J. Reyes L. F. Brackel C. L. H. Fomin V. Svistunov A. A. Timashev P. Mazankova L. Miroshina A. Samitova E. Borzakova S. Bondarenko E. Korsunskiy A. A. Carson G. Sigfrid L. Scott J. T. Greenhawt M. Buonsenso D. Semple M. G. Warner J. O. Olliaro P. Needham D. M. Glybochko P. Butnaru D. Osmanov I. M. Munblit D. Sechenov StopCOVID Research Team: Prevalence and risk factors of post-COVID-19 condition in adults and children at 6 and 12 months after hospital discharge: a prospective, cohort study in Moscow (StopCOVID). *BMC medicine* 2022; 20(1): 244.
- Peters C, Dulon M. Westermann C. Kozak A. Nienhaus A.: Long-Term Effects of COVID-19 on Workers in Health and Social Services in Germany. *International journal of environmental research and public health* 2022; 19(12).

- Philip Kej, Owles H. McVey S. Pagnuco T. Bruce K. Brunjes H. Banya W. Mollica J. Lound A. Zumpe S. Abrahams A. M. Padmanaban V. Hardy T. H. Lewis A. Lalvani A. Elkin S. Hopkinson N. S.: An online breathing and wellbeing programme (ENO Breathe) for people with persistent symptoms following COVID-19: a parallel-group, single-blind, randomised controlled trial. *Lancet respiratory medicine* 2022.
- Pierce JD, Shen Q, Cintron SA, Hiebert JB: Post-COVID-19 Syndrome. *Nurs Res* 2022; 71(2): 164–74.
- Pinzon RT, Wijaya VO, Jody AA, Nunsio PN, Buana RB: Persistent neurological manifestations in long COVID-19 syndrome: A systematic review and meta-analysis. *J Infect Public Health* 2022; 15(8): 856–69.
- Pires, Ícaro Almeida Toledo Steffens Sara Thais Mocelin Aurenzo Gonçalves Shibukawa Debora Emi Leahy Letícia Saito Fernanda Laís Amadeu Nicole Tássia Lopes Natália Medeiros Dias Garcia Ellen Cristine Duarte Albanese Maria Laura Mari Laura Freitas De Ferreira Isabel Moura Veiga César Antônio Jebahi Yasser Coifman Hertton Fornazieri Marco Aurélio Hamerschmidt Rogerio: Intensive Olfactory Training in Post-COVID Patients: A Randomized Multicenter Clinical Trial (preprint). doi:10.1590/scielo-preprints.3301.
- Premraj L, Kannapadi NV, Briggs J, et al.: Mid and long-term neurological and neuropsychiatric manifestations of post-COVID-19 syndrome: A meta-analysis. *J Neurol Sci* 2022; 434: 120162.
- Qiangru H, Mengmeng J, Yanxia S, et al.: One-Year Temporal Change in Prevalence and Characteristic of Long COVID: A Systematic Review and Meta-Analysis. *SSRN* 2022.
- Qureshi Ai, Baskett W. I. Huang W. Naqvi S. H. Shyu C. R.: New-Onset Dementia Among Survivors of Pneumonia Associated With Severe Acute Respiratory Syndrome Coronavirus 2 Infection. *Open forum infectious diseases* 2022; 9(4): ofac115.
- Rabady S, Altenberger J, Brose M, et al.: [Guideline S1: Long COVID: Diagnostics and treatment strategies]. *Wien Klin Wochenschr* 2021; 133(Suppl 7): 237–78.
- Ramadan MS, Bertolino L, Zampino R, Durante-Mangoni E, Monaldi Hospital Cardiovascular Infection Study, Group: Cardiac sequelae after coronavirus disease 2019 recovery: a systematic review. *Clin Microbiol Infect* 2021; 27(9): 1250–61.
- Ranade M, Deshmukh P, Purushotham S, Kasliwal P: Systematic Review of Post Covid Myalgia Literature 2021; 4(2).
- Rao S, Lee G. M. Razzaghi H. Lorman V. Mejias A. Pajor N. M. Thacker D. Webb R. Dickinson K. Bailey L. C. Jhaveri R. Christakis D. A. Bennett T. D. Chen Y. Forrest C. B.: Clinical features and burden of post-acute sequelae of SARS-CoV-2 infection in children and adolescents: an exploratory EHR-based cohort study from the RECOVER program. *Medrxiv* 2022.
- Rao S, Benzouak T, Gunpat S, et al.: Fatigue Symptoms Associated With COVID-19 in Convalescent or Recovered COVID-19 Patients; a Systematic Review and Meta-Analysis. *Annals of behavioral medicine a publication of the Society of Behavioral Medicine* 2021.
- Rathi A, Jadhav S. B. Shah N.: A Randomized Controlled Trial of the Efficacy of Systemic Enzymes and Probiotics in the Resolution of Post-COVID Fatigue. *Medicines (Basel, Switzerland)* 2021; 8(9).
- Rauniyar R, Mishra A, Kharel S, Giri S, Yadav S, Chaudhary G: IVIG plus Glucocorticoids versus IVIG Alone in Multisystem Inflammatory Syndrome in Children (MIS-C) Associated with COVID-19: A Systematic Review and Meta-Analysis. *Can* 2022; 2022: 9458653.

- Raveendran AV, Jayadevan R, Sashidharan S: Long COVID: An overview. *Diabetes Metab Syndr* 2021; 15(3): 869–75.
- Renaud-Charest O, Lui LMW, Eskander S, et al.: Onset and frequency of depression in post-COVID-19 syndrome: A systematic review. *J Psychiatr Res* 2021; 144: 129–37.
- Reyes Domingo F, Waddell LA, Cheung AM, et al.: Prevalence of long-term effects in individuals diagnosed with COVID-19: an updated living systematic review. *Medrxiv* 2021.
- Robineau O, Wiernik E, Lemogne C, de Lamballerie X, Ninove L, Blanche H, Deleuze J, F. Ribet C, Kab S, Goldberg M, Severi G, Touvier M, Zins M, Carrat F.: Persistent symptoms after the first wave of COVID-19 in relation to SARS-CoV-2 serology and experience of acute symptoms: a nested survey in a population-based cohort. *The lancet regional health. Europe* 2022; 17: 100363.
- Rodenas-Alesina E, Rodriguez-Palomares J, Bach-Oller M, Jordan P, Badia C, Herrador L, Garcia-de-Acilu M, Clau-Terre F, Gonzalez-Del-Hoyo M, Fernandez-Galera R, Servato L, Casas G, Baneras J, Ferreira-Gonzalez I.: Echocardiographic assessment of COVID19 sequelae in survivors with elevated cardiac biomarkers. *International journal of cardiology* 2022; 360: 104–10.
- Sabbour M, El-Swaify ST, Farrag N, et al.: Multisystem inflammatory syndrome in children (MIS-C) temporally associated with SARS-CoV-2 infection: a scoping review of the literature. *Medrxiv* 2020: 2020.08.03.20167361.
- Salamanna F, Veronesi F, Martini L, Landini MP, Fini M: Post-COVID-19 Syndrome: The Persistent Symptoms at the Post-viral Stage of the Disease. A Systematic Review of the Current Data. *Front Med (Lausanne)* 2021; 8: 653516.
- Santarossa S, Rapp A, Sardinias S, Hussein J, Ramirez A, Cassidy-Bushrow A, E. Cheng P, Yu E.: Understanding the #longCOVID and #longhaulers Conversation on Twitter: multimethod Study. *JMIR infodemiology* 2022; 2(1): e31259.
- Sarfraz Z, Sarfraz A, Barrios A, et al.: Cardio-Pulmonary Sequelae in Recovered COVID-19 Patients: Considerations for Primary Care. *J* 2021; 12: 21501327211023726.
- Sayed Ia, Bhalala U, Strom L, Tripathi S, Kim J, S. Michaud K, Chiotos K, Dapul H, R. Gharpure V, P. Bjornstad E, C. Heneghan J, A. Irby K, Montgomery V, Gupta N, Gupta M, Boman K, Bansal V, Kashyap R, Walkey A, J. Kumar V, K. Gist K, M. Virus Investigators: Gastrointestinal Manifestations in Hospitalized Children With Acute SARS-CoV-2 Infection and Multisystem Inflammatory Condition: an Analysis of the VIRUS COVID-19 Registry. *Pediatric infectious disease journal* 2022.
- Schneeberger T, Berkel S, Jarosch I, et al.: Effects of an Automatically Titrating Oxygen-Flow System During Walking in Hypoxemic Post-COVID-19 Patients - a Pilot Randomized Controlled Double-Blind Cross Over Trial. *American Journal of Respiratory and Critical Care Medicine* 2022; 205: 2.
- Schou TM, Joca S, Wegener G, Bay-Richter C: Psychiatric and neuropsychiatric sequelae of COVID-19 - A systematic review. *Brain Behav Immun* 2021; 97: 328–48.
- Serin I, Sari N, D. Gunaltili M, Karakilic A, Gulesir B, Kal Kolik B, Cevik G, Sungurlu H, Keskin M, Baltik M, Cakmak O, Cinli T, A.: Enigma of COVID-19: is "multisystem inflammatory syndrome in adults" (MIS-A) predictable? *BMC infectious diseases* 2022; 22(1): 300.
- SeyedAlinaghi S, Afsahi AM, MohsseniPour M, et al.: Late Complications of COVID-19; a Systematic Review of Current Evidence. *Arch* 2021; 9(1): e14.

- Shanbehzadeh S, Tavahomi M, Zanjari N, Ebrahimi-Takamjani I, Amiri-Arimi S: Physical and mental health complications post-COVID-19: Scoping review. *J Psychosom Res* 2021; 147: 110525.
- Shein SI, Carroll C. L. Remy K. E. Rogerson C. M. McCluskey C. K. Lin A. Rotta A. T.: Epidemiology and Outcomes of SARS-CoV-2 Infection or Multisystem Inflammatory Syndrome in Children vs Influenza Among Critically Ill Children. *JAMA network open* 2022; 5(6): e2217217.
- Shi Q, Wang Z, Liu J, et al.: Risk factors for poor prognosis in children and adolescents with COVID-19: A systematic review and meta-analysis. *EClinicalMedicine* 2021; 41: 101155.
- Scottish Intercollegiate Guidelines Network (SIGN): Managing the long-term effects of COVID-19. SIGN 2021.
- Simon D, Michèle D, Théo S, et al.: Care Models for Long COVID: A Rapid Systematic Review. *Medrxiv* 2021.
- Sinwan Basharat SM: A Condition-Level Review on Post-COVID-19 Condition (Long COVID). *CADTH Scoping Summary* 2021; *CADTH Scoping Summary*.
- Siso-Almirall A, Brito-Zeron P, Conangla Ferrin L, et al.: Long Covid-19: Proposed Primary Care Clinical Guidelines for Diagnosis and Disease Management. *Int J Environ Res Public Health* 2021; 18(8): 20.
- So M, Kabata H, Fukunaga K, Takagi H, Kuno T: Radiological and functional lung sequelae of COVID-19: a systematic review and meta-analysis. *BMC pulm* 2021; 21(1): 97.
- Sorensen A I V, Spiliopoulos L, Bager P. M. Nielsen N. M. Hansen J. V. Koch A. Meder I. K. Ethelberg S. Hviid A.: Post-acute symptoms, new onset diagnoses and health problems 6 to 12 months after SARS-CoV-2 infection: a nationwide questionnaire study in the adult Danish population. *Medrxiv* 2022.
- Soriano-Moreno AN, Soriano-Moreno DR, Pacheco-Barrios N, Lescano AG, Checkley W: A systematic review of the frequency of persistent constitutional and respiratory symptoms related to COVID-19: A new long COVID syndrome? *Am. J. Respir. Crit. Care Med.* 2021; 203(9).
- Soril LJJ, Damant RW, Lam GY, et al.: The effectiveness of pulmonary rehabilitation for Post-COVID symptoms: A rapid review of the literature. *Respir Med* 2022; 195: 106782.
- Spiers N: Reassessment of persistent symptoms, self-reported COVID-19 infection and SARS-CoV-2 serology in the SAPRIS-SERO cohort: identifying possible sub-syndromes of Long Covid. *Medrxiv* 2022.
- Srinivasan V, Kandakurti P. K. Alagesan J. Suganthirababu P. Kishore Jebasingh T. Jennifer Augustina S. Anitha A.: Efficacy of pursed lip breathing with bhastrika pranayama vs incentive spirometry in rehabilitating post Covid 19 follow up-a randomized control study. *Turkish journal of physiotherapy and rehabilitation* 2021; 32(3): 402–7.
- Stephenson T, Pinto Pereira SM, Shafran R, et al.: Physical and mental health 3 months after SARS-CoV-2 infection (long COVID) among adolescents in England (CLOCK): a national matched cohort study. *The Lancet Child & Adolescent Health* 2022; 6(4): 230–9.
- Sylvester SV, Rusu R, Chan B, Bellows M, O'Keefe C, Nicholson S: Sex differences in sequelae from COVID-19 infection and in long COVID syndrome: a review. *Curr Med Res Opin* 2022: 1–9.
- Tannous J, Pan A, Potter T, et al.: Real World Evidence of Effectiveness of COVID-19 Vaccines and Anti SARS-CoV-2 Monoclonal Antibodies Against Post-Acute Sequelae of SARS-CoV-2 Infection. *Medrxiv* 2022.

- Tehseen S, Williams S, Robinson J, Morris S, K. Bitnu A, Gill P, Tal T, E. Yeh A, Yea C, Ulloa-Gutierrez R, Brenes-Chacon H, Yock-Corrales A, Ivankovich-Escoto G, Soriano-Fallas A, Papenburg J, Lefebvre M, A. Scuccimarri R, Nateghian A, Aski B, H. Dwilow R, Bullard J, Cooke S, Restivo L, Lopez A, Sadarangani M, Roberts A, Forbes M, Saux N, L. Bowes J, Purewal R, Lautermilch J, Bayliss A, Wong J, K. Leifso K, Foo C, Panetta L, Kakkar F, Piche D, Viel-Therriault I, Merckx J, Lieberman L.: Thrombosis and hemorrhage experienced by hospitalized children with SARS-CoV-2 infection or MIS-C: results of the PICNIC registry. *Pediatric blood & cancer* 2022; e29793.
- Tleyjeh Im, Kashour T, Riaz M, Amer S, A. AlSwaidan N, Almutairi L, Halwani R, Assiri A.: Persistent COVID-19 symptoms at least one month after diagnosis: a national survey. *Journal of infection and public health* 2022; 15(5): 578–85.
- Trapani G, Verlato G, Bertino E, Maiocco G, Vesentini R, Spadavecchia A, Dessi A, Fanos V.: Long COVID-19 in children: an Italian cohort study. *Italian journal of pediatrics* 2022; 48(1): 83.
- Tuvali O, Tshori S, Derazne E, Hannuna R, R. Afek A, Haberman D, Sella G, George J.: The Incidence of Myocarditis and Pericarditis in Post COVID-19 Unvaccinated Patients-A Large Population-Based Study. *Journal of clinical medicine* 2022; 11(8).
- van Hattum JC, Spies JL, Verwijs SM, et al.: Cardiac abnormalities in athletes after SARS-CoV-2 infection: a systematic review. *BMJ open sport & exercise medicine* 2021; 7(4): e001164.
- van Kessel SAM, Olde Hartman TC, Lucassen P, van Jaarsveld CHM: Post-acute and long-COVID-19 symptoms in patients with mild diseases: a systematic review. *Fam Pract* 2022; 39(1): 159–67.
- van Maaden T MEdBSLKYKHSJTADWAHAJFEWCC: Prevalence and severity of symptoms 3 months after infection with SARS-CoV-2 compared to test-negative and population controls in the Netherlands. *Medrxiv* 2022.
- Vanderlind WM, Rabinovitz BB, Miao IY, et al.: A systematic review of neuropsychological and psychiatric sequelae of COVID-19: implications for treatment. *Current opinion in psychiatry* 2021; 34(4): 420–33.
- Verma A, Huffman J, E. Gao L, Minnier J, Wu W, C. Cho K, Ho Y, L. Gorman B, R. Pyarajan S, Rajeevan N, Garcon H, Joseph J, McGeary J, E. Suzuki A, Reaven P, D. Wan E, S. Lynch J, A. Petersen J, M. Meigs J, B. Freiberg M, S. Gatsby E, Lynch K, E. Zekavat S, M. Natarajan P, Dalal S, Jhala D, N. Arjomandi M, Bonomo R, A. Thompson T, K. Pathak G, A. Zhou J, J. Donskey C, J. Madduri R, K. Wells Q, S. Gelernter J, Huang R, D. L. Polimanti R, Chang K, M. Liao K, P. Tsao P, S. Sun Y, V. Wilson P, W. F. O'Donnell C, J. Hung A, M. Gaziano J, M. Hauger R, L. Iyengar S, K. Luoh S, W. V. A. Million Veteran Program Covid-Science Initiative: Association of Kidney Comorbidities and Acute Kidney Failure With Unfavorable Outcomes After COVID-19 in Individuals With the Sick Cell Trait. *JAMA internal medicine* 2022.
- Vestito L, Mori L, Trompetto C, Bagnasco D, Canevari R, F. Ponzano M, Subbrero D, Cecchella E, Barbara C, Clavario P, Bandini F.: Impact of tDCS on persistent COVID-19 olfactory dysfunction: a double-blind sham-controlled study. *Journal of neurology, neurosurgery, and psychiatry* 2022.
- Vieira A, Pinto A, Garcia B, Eid RAC, Mol CG, Nawa RK: Telerehabilitation improves physical function and reduces dyspnoea in people with COVID-19 and post-COVID-19 conditions: a systematic review. *J Physiother* 2022; 68(2): 90–8.
- Vitaliti G, Giacchi V, Sciacca M, Ruggieri M, Falsaperla R: Thrombotic events in children and adolescent patients with SARS-Cov-2 infection: a systematic review with meta-analysis on incidence and management. *Expert review of hematology* 2022.

- Vollbracht C, Kraft K: Feasibility of Vitamin C in the Treatment of Post Viral Fatigue with Focus on Long COVID, Based on a Systematic Review of IV Vitamin C on Fatigue. *Nutrients* 2021; 13(4): 31.
- Wang Z, Zhao S, Tang Y, et al.: Potentially Effective Drugs for the Treatment of COVID-19 or MIS-C in Children: A Systematic Review. *ResearchSquare* 2021.
- Wasilewski MB, Cimino SR, Kokorelias KM, Simpson R, Hitzig SL, Robinson L: Providing Rehabilitation to Patients Recovering from COVID-19: A Scoping Review. *PM & R the journal of injury, function, and rehabilitation* 2021.
- Watanabe A, So M, Iwagami M, et al.: One-year follow-up CT findings in COVID-19 patients: A systematic review and meta-analysis. *Respirology (Carlton, Vic.)* 2022.
- Webster KE, O'Byrne L, MacKeith S, Philpott C, Hopkins C, Burton MJ: Interventions for the prevention of persistent post-COVID-19 olfactory dysfunction. *Cochrane Database Syst Rev* 2021; 7: CD013877.
- Whitaker M, Elliott J, Chadeau-Hyam M, Riley S, Darzi A, Cooke G, Ward H, Elliott P.: Persistent COVID-19 symptoms in a community study of 606,434 people in England. *Nature communications* 2022; 13(1): 1957.
- Whitaker M, Elliott J, Chadeau-Hyam M, et al.: Persistent symptoms following SARS-CoV-2 infection in a random community sample of 508,707 people 2021.
- Whittaker A, Anson M, Harky A: Neurological Manifestations of COVID-19: A systematic review and current update. *Acta neurologica Scandinavica* 2020; 142(1): 14–22.
- Willi S, Luthold R, Hunt A, et al.: COVID-19 sequelae in adults aged less than 50 years: A systematic review. *Travel Med Infect Dis* 2021; 40: 101995.
- Williamson A E, Tydeman F, Miners A, Pyper K, Martineau A. R.: Acute and long-term impacts of COVID-19 on economic vulnerability: a population-based longitudinal study (COVIDENCE UK). *Medrxiv* 2022.
- Wong TL, Weitzer DJ: Long COVID and Myalgic Encephalomyelitis/Chronic Fatigue Syndrome (ME/CFS)-A Systemic Review and Comparison of Clinical Presentation and Symptomatology. *Medicina (Kaunas)* 2021; 57(5): 26.
- Wong-Chew Rm, Rodriguez Cabrera E. X, Rodriguez Valdez C. A, Lomelin-Gascon J, Morales-Juarez L, de la Cerda M. L, R, Villa-Romero A, R, Arce Fernandez S, Serratos Fernandez M, Bello H, H, Castaneda L, M, Avendano M, A, Hernandez-Cruz J, A, Alvarez Martinez N, Fernanda Contreras L, Rafael Gonzalez de la Cerda L, Juarez Flores A, Martinez-Juarez L, A, Alvarez-Hernandez D, A, Gallardo-Rincon H, Fajardo Dolci G, Tapia-Conyer R, Valdez-Vazquez R, R.: Symptom cluster analysis of long COVID-19 in patients discharged from the Temporary COVID-19 Hospital in Mexico City. *Therapeutic advances in infectious disease* 2022; 9: 20499361211069264.
- Writing C, Gluckman TJ, Bhave NM, et al.: 2022 ACC Expert Consensus Decision Pathway on Cardiovascular Sequelae of COVID-19 in Adults: Myocarditis and Other Myocardial Involvement, Post-Acute Sequelae of SARS-CoV-2 Infection, and Return to Play: A Report of the American College of Cardiology Solution Set Oversight Committee. *J Am Coll Cardiol* 2022; 79(17): 1717–56.
- Wu Q, Ailshire J, Crimmins E.: Long COVID and Symptom Trajectory in a Representative Sample of Americans. *Research square* 2022.
- Wu TJ, Yu AC, Lee JT: Management of post-COVID-19 olfactory dysfunction. *Curr Treat Options Allergy* 2022; 9(1): 1–18.
- Xiang Y, Zhang R, Q. I. U. J, So H, C.: Association of COVID-19 with risks of hospitalization and mortality from other disorders post-infection: a study of the UK Biobank. *Medrxiv* 2022.

- Xie Y A-AZ: Risks and burdens of incident diabetes in long COVID: a cohort study. *The lancet. Diabetes & endocrinology* 2022; 10(5): 311–21.
- Xie Y, Xu E. Bowe B. Al-Aly Z.: Long-term cardiovascular outcomes of COVID-19. *Nature medicine* 2022; 28(3): 583–90.
- Yakut N, Yuksel E. Algul M. Armut M. Sahin B. Karagoz G. Yakut K. Kilinc A. Tanidir I. C.: Comparison of clinical and laboratory features in coronavirus disease 2019 and pediatric multisystem inflammatory syndrome patients. *Pediatrics international* 2022; 64(1): e14884.
- Yang T, Yan MZ, Li X, Lau EHY: Sequelae of COVID-19 among previously hospitalized patients up to 1 year after discharge: a systematic review and meta-analysis. *Infection* 2022; 24: 24.
- Yelin D, Margalit I. Nehme M. Bordas-Martinez J. Pistelli F. Yahav D. Guessous I. Dura-Miralles X. Carrozzi L. Shapira-Lichter I. Vetter P. Peleato-Catalan D. Tiseo G. Wirthem E. Kaiser L. Gudiol C. Falcone M. Leibovici L. On Behalf Of The LongCOV Research Group: Patterns of Long COVID Symptoms: a Multi-Center Cross Sectional Study. *Journal of clinical medicine* 2022; 11(4).
- Yelin D, Moschopoulos CD, Margalit I, et al.: ESCMID rapid guidelines for assessment and management of long COVID. *Clin Microbiol Infect* 2022; 28(7): 955–72.
- Yilmaz Ciftdogan D, Ekemen Keles Y. Cetin B. S. Dalgic Karabulut N. Emiroglu M. Bagci Z. Buyukcam A. Erdeniz E. H. Arga G. Yesil E. Cakici O. Karbuz A. Sahbudak Bal Z. Kara S. S. Ozer A. Metin Akcan O. Elmas Bozdemir S. Anil A. B. Uygun H. Kilic O. Hancerli Torun S. Umit Z. Sutcu M. Ozgokce Ozmen B. Karaoglu Asrak H. Alkan G. Kara Aksay A. Ugur C. Birbilen A. Z. Bursal Duramaz B. Akyuz Ozkan E. Burakay O. Yildirim Arslan S. Karadag Oncel E. Celik S. F. Kilic A. O. Ozen S. Sarikaya R. Demirkol D. Arslan G. Turel O. Sert A. Sari E. Orbak Z. Sahin I. O. Varan C. Akturk H. Tuter Oz S. K. Durak F. Oflaz M. B. Kara M. Karpuz D. Talip Petmezci M. Hatipoglu N. Oncel S. Turgut M. Elmali F. Somer A. Kuyucu N. Dinleyici E. C. Kurugol Z. Ciftci E. Kara A.: COVID-19 associated multisystemic inflammatory syndrome in 614 children with and without overlap with Kawasaki disease-Turk MIS-C study group. *European journal of pediatrics* 2022; 181(5): 2031–43.
- Yilmaz Ciftdogan D, Ekemen Keles Y. Karbuz A. Cetin B. S. Elmas Bozdemir S. Kepenekli Kadayifci E. Metin Akcan O. Ozer A. Erat T. Sutcu M. Buyukcam A. Belet N. Erdeniz E. H. Dalgic Karabulut N. Hancerli Torun S. Oncel S. Orbak Z. Turel O. Gayretli Aydin Z. G. Kilic O. Yahsi A. Kara Aksay A. Ergenc Z. Petmezci M. T. Oflaz M. B. Sarikaya R. Otar Yener G. Ozen S. Gul D. Arslan G. Kara S. S. Demirkol D. Yazici Ozkaya P. Yozgat Y. Varan C. Kara M. Arga G. Yakut N. Kilic A. O. Cakici O. Kucuk M. Kaba O. Karaoglu Asrak H. Bursal Duramaz B. Dalkiran T. Berna Anil A. Turgut M. Karapinar B. Somer A. Elmali F. Dinleyici E. C. Ciftci E. Kara A.: Multisystem inflammatory syndrome in children associated with COVID-19 in 101 cases from Turkey (Turk-MISC study). *Journal of paediatrics and child health* 2022; 58(6): 1069–78.
- Yi-Sheng Chao, Thyna Vu, Sarah C. McGill, Michelle Gat: Clinical Classification and Interventions for Post-COVID-19 Condition: A Scoping Review CADTH Health Technology Review. *Canadian Journal of Health Technologie* 2022; 2(5).
- Yoo Sm, Liu T. C. Motwani Y. Sim M. S. Viswanathan N. Samras N. Hsu F. Wenger N. S.: Factors Associated with Post-Acute Sequelae of SARS-CoV-2 (PASC) After Diagnosis of Symptomatic COVID-19 in the Inpatient and Outpatient Setting in a Diverse Cohort. *Journal of general internal medicine* 2022.
- Yousef MS, Idris NS, Yap C, Alsubaie AA, Kakodkar P: Systematic review on the clinical presentation and management of the COVID-19 associated multisystem inflammatory syndrome in children (MIS-C). *BMC Proc.* 2021; 15(SUPPL 4).

- Zambrano Ld, Newhams M. M. Olson S. M. Halasa N. B. Price A. M. Boom J. A. Sahni L. C. Kamidani S. Tarquinio K. M. Maddux A. B. Heidemann S. M. Bhumbra S. S. Blinc K. E. Nofziger R. A. Hobbs C. V. Bradford T. T. Cvijanovich N. Z. Irby K. Mack E. H. Cullimore M. L. Pannaraj P. S. Kong M. Walker T. C. Gertz S. J. Michelson K. N. Cameron M. A. Chiotos K. Maamari M. Schuster J. E. Orzel A. O. Patel M. M. Campbell A. P. Randolph A. G. Overcoming Covid-Investigators: Effectiveness of BNT162b2 (Pfizer-BioNTech) mRNA Vaccination Against Multisystem Inflammatory Syndrome in Children Among Persons Aged 12-18 Years - United States, July-December 2021. *MMWR. Morbidity and mortality weekly report* 2022; 71(2): 52–8.
- Zeng N, Zhao YM, Yan W, et al.: A systematic review and meta-analysis of long term physical and mental sequelae of COVID-19 pandemic: call for research priority and action. *Mol Psychiatry* 2022; 06: 6.
- Zhang Hg, Dagliati A. Shakeri Hossein Abad Z. Xiong X. Bonzel C. L. Xia Z. Tan B. W. Q. Avillach P. Brat G. A. Hong C. Morris M. Visweswaran S. Patel L. P. Gutierrez-Sacristan A. Hanauer D. A. Holmes J. H. Samayamuthu M. J. Bourgeois F. T. L'Yi S. Maidlow S. E. Moal B. Murphy S. N. Strasser Z. H. Neuraz A. Ngiam K. Y. Loh N. H. W. Omenn G. S. Prunotto A. Dalvin L. A. Klann J. G. Schubert P. Vidorreta F. J. S. Benoit V. Verdy G. Kavuluru R. Estiri H. Luo Y. Malovini A. Tibollo V. Bellazzi R. Cho K. Ho Y. L. Tan A. L. M. Tan B. W. L. Gehlenborg N. Lozano-Zahonero S. Jouhet V. Chiovato L. Aronow B. J. Toh E. M. S. Wong W. G. S. Pizzimenti S. Waghlikar K. B. Bucalo M. Consortium for Clinical Characterization of Covid-by E. H. R. Cai T. South A. M. Kohane I. S. Weber G. M.: International electronic health record-derived post-acute sequelae profiles of COVID-19 patients. *NPJ digital medicine* 2022; 5(1): 81.
- Ziauddeen N, Gurdasani D. O'Hara M. E. Hastie C. Roderick P. Yao G. Alwan N. A.: Characteristics and impact of Long Covid: findings from an online survey. *PloS one* 2022; 17(3): e0264331.
- Zürcher SJ, Banzer C, Adamus C, Lehmann AI, Richter D, Kerksieck P: Post-viral mental health sequelae in infected persons associated with COVID-19 and previous epidemics and pandemics: Systematic review and meta-analysis of prevalence estimates. *Journal of infection and public health* 2022.