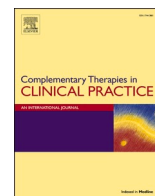




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Yoga for COVID-19: An ancient practice for a new condition – A literature review

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ABSTRACT

A substantial proportion of people with acute COVID-19 develop post-COVID-19 condition (previously known as long-COVID) characterized by symptoms that persist for months after the initial infection, including neuropsychological sequelae. Post-COVID-19 condition frequency varies greatly according to different studies, with values ranging from 4 to 80% of the COVID-19 patients.

Yoga is a psycho-somatic approach that increases physical, mental, emotional and spiritual strength, and connection. Yoga practice enhances innate immunity and mental health, so it can be used as complementary therapy in the COVID-19 treatment, namely the post-COVID-19 condition.

In this article, we conducted a literature review on yoga and COVID-19, finding that an intervention comprising asana, pranayama, and meditation may be a strategy of choice for these patients' recovery. However, further studies are needed to show its effectiveness in this, still unknown, context.

1. Introduction

Currently, the world is facing an outbreak of a highly infectious disease named COVID-19. This disease is caused by the novel coronavirus SARS-Cov-2, which is a positive-sense single-stranded RNA virus [1]. In humans, this virus enters the host cells through the receptor angiotensin-converting enzyme 2 (ACE2) with the help of a spike (S) protein [2]. The infected individuals may present mild to moderate symptoms, with an important proportion requiring hospitalization due symptom severity and sudden deterioration [3]. The most common symptoms are profound fatigue, dyspnea, sleep difficulties, anxiety or depression, reduced lung capacity, memory/cognitive impairment, and hyposmia/anosmia [4].

For some patients the symptoms are harsh and longer lasting [5], and may result in the post-COVID-19 condition, characterized by the presence of COVID-19 symptoms with a duration of ≥ 2 months [4]. The frequency of this condition varies greatly according to different studies, with values ranging from 4 to 80% of the COVID-19 patients [4].

In a cohort of 97 post-COVID-19 condition patients which were followed-up prospectively from month 5, only 22.9% were completely free of symptoms at month 12 [6]. In a larger study, including 2320 adults recruited for the post-hospitalization COVID-19 study, discharged from hospital across the UK following hospital admission with COVID-19, a minority felt fully recovered at 1 year. This is important, considering there are no effective pharmacological or non-pharmacological interventions for post-COVID-19 symptoms [6]. Beyond the direct effects of SARS-CoV-2 infection involving the lung parenchyma, the post-viral long-term complications of post-COVID-19 condition mainly affecting the central nervous system are still largely unknown. Ongoing symptoms of inattention, executive function, memory loss, anosmia, ageusia, headaches, cerebrovascular accidents and meningoencephalitis have been diagnosed in patients under 60 [7]. More larger clinical studies are required to understand the duration and the long-term effects of the post-COVID-19 condition [8], since the condition may affect millions of people around the world [9]. According to the recent Delphi consensus to end the COVID-19 public health threat,

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the post-COVID-19 condition has emerged as a serious chronic condition still lacking adequate understanding and appropriate preventive or curative solutions [10]. The consensus recommended that research funding for this condition should be prioritized [10].

The growing field of Integrative Medicine research crosses with the intensive search for successful treatments for COVID-19 infection [11]. The practice of yoga, including pranayama and meditation, may modulate stress and inflammation, and possible forms of immune system enhancement, along with potential implications for counteracting some forms of infectious challenges [11,12]. The ability to proactively handle everyday life stress may lighten the constant activation of the endocrine system, increasing the effectiveness of the immune system [13].

In this article, we conducted a literature review on PubMed using the keywords “yoga” and “COVID-19”, to assess the suitability of yoga as a therapy for COVID treatment. Currently, there are no published data on the effects of yoga use for COVID-19 symptoms improvement, other than some scarce ongoing clinical trials. However, since yoga practice enhances innate immunity and mental health [14], it can be proposed as a complementary therapy in the COVID-19 treatment, namely the post-COVID-19 condition. The use of yoga to alleviate the COVID 19 burden in non-patients (e.g. health care workers, lockdown effects, anxiety/fear caused by the pandemic, social isolation) is also discussed.

2. Yoga as an ancient practice

Yoga is an ancient Indian practice aiming to achieve the equilibrium of mind and body by controlling person’s emotions [15]. According to the Indian tradition and to archaeological evidence (namely seals containing postures that were found at Mohenjo-Daro), it has been said that yoga originated in the Indus Valley around 5000 years ago [16,17]. However, recent data refute this theory, arguing that prior to 500 BC there is very little evidence in South Asian textual or archaeological sources pointing to the existence of systematic, psycho-physical techniques that can be considered as what the word “yoga” later came to mean [18].

Yoga is mentioned in the classic Indian poem Mahabharata (400 BC-400 AD), being discussed in the most famous part of that poem, the Bhagavad-gita [19]. Yoga was systematized by Patanjali in the Yoga Sutras around the 4th century AD [20,21]. Patanjali defined the ultimate goal of yoga (and of human existence) as self-realization (using a neo-Vedantic term), the final state of consciousness, the state of consciousness in which nothing can be discerned except the pure self [20]. Therefore, yoga has begun as a contemplative practice aiming at the transformation of the self through the systematic use of particular behavioral and spiritual practices [22]. In its spiritual approach, yoga postures were originally created for building muscles so the practitioner would be able to do seated meditation for hours.

Yoga relies on the holistic principle of connecting the body, mind, and consciousness [23]. It is a psycho-somatic approach which equilibrates all parts of one’s life from the physical, mental, emotional to spiritual spectrum [7]. The practice of yoga unifies the mind and body through its three pillars: asana (body postures), pranayama (breathing exercise), and meditation with or without chanting mantras [12,23,24].

Ancient yogis did not consider yoga to be a therapy; for them yoga was a path to liberation, a way to end suffering [25]. However, they found that yoga allowed them to have more health, which was good for spiritual development, since illness was an impediment to the practice [25].

3. Yoga as a mind-body approach for health

Modern yoga emerged in the late nineteenth to the mid-twentieth century, from the bridge between the worlds of Indian spirituality and European physical culture [19,26], resulting in a practice with extraordinary international and cross-cultural appeal [26]. Nowadays, yoga has become an integral part of modern society, and its popularity is

growing exponentially [22]. An example of yoga widespread cultural influence is the proclamation by the United Nations General Assembly of the International Yoga Day, which occurs at 21 June since 2014 [22].

Research on the psychophysiological effects of yoga practice began with the work of Sri Kuvalayananda in 1920 [27] who published his results in the first journal dedicated to yoga research (Yoga Mimamsa) that he launched in 1924 [21,24]. The techniques of yoga, which were originally conceived for the removal of human suffering, may be considered as a psychophysiological therapy [28]. Yoga began to be considered as a therapeutic intervention at the beginning of the twentieth century [22]. For instance, B. K. S. Iyengar adapted yoga for therapeutic purposes, and in this context has pioneered the use of props such as wood blocks, benches, bolsters, and straps while doing the postures [21], making them easier to perform in the context of a disease condition.

The use of yoga as a mind-body approach for health became widespread with the increase in both biomedical research on psychophysiology of yoga practices and clinical trials on yoga therapy, supported in part by the NIH in the USA, and the Ministry of AYUSH in India [22].

Yoga can reduce the fight or flight stress response by increasing vagal stimulation [23,29]. Psychosocial stress can reduce immunity against infections and overstimulate host inflammatory responses, leading to tissue damage and even death [23].

Yogic practices help in the management of stress and stress-induced disorders via downregulation of the hypothalamic-pituitary-adrenal (HPA) axis response to stress, thus improving parasympathetic activity [12,30,31]. The inhibition of the sympathetic area of the hypothalamus optimizes the body’s sympathetic responses to stressful stimuli, reestablishing the stress-associated autonomous regulatory reflex mechanisms [32]. In addition to allowing for a predominance of the parasympathetic state, yoga may also promote effective extraction of oxygen by peripheral tissues [33].

Yoga has been reported as changing brain activation patterns and altering the perception of pain [34]. An increase in amygdala and frontal cortex activation has been observed after a yoga intervention, along with an increase in gray matter [34]. The observed increase in brain wave activity may explain the decreases in anxiety and increases in focus which occur after yoga training interventions [34].

Sometimes yoga is equated with physical exercise, but the aim of yoga is to control the mental modifications with physical postures as one of the scaffolds [35]. This is why asana are performed with slow movements, synchronized breathing and mindful awareness, differently from other physical exercises [35]. Compared to physical exercise, yoga may be more effective in improving health related conditions [29].

4. Why should we use yoga for COVID-19 disease?

The Eastern mind-body practices have become more popular since the COVID-19 pandemic, due to the mental health concerns the pandemic has created among the general population worldwide [36].

Yoga and meditation are known to help in alleviating mental stress and anxiety [12,37,38], having a positive effect on psychological well-being [37]. So, yoga may have an important role in the psycho-social aspects and recovery of COVID-19 patients who have been isolated and disengaged, namely through the adjustment of their anxiety feelings [37,39,40]. Stress, anxiety and depression may be associated with increased susceptibility to viral upper respiratory infections, suggesting that the assumption of an association between psychological distress and a weak immune response to COVID-19 infection is biologically plausible [41].

Yoga practice is a potential strategy for enhancing innate immunity and mental health, justifying its use as adjunctive treatment in COVID-19 [14]. Due to its immunity-boosting potential, yoga may diminish the severity of the disease, preventing the exaggerated immune response to the cytokine storm, which plays a pivotal role in the disease aggravation [3,14].

Yoga has been associated with various cardioprotective effects, preventing lung and cardiac injury, what is also important in COVID-19 [14]. In an early phase of COVID-19, a yoga intervention may offer an indirect antiviral effect due to its anti-inflammatory, anti-oxidation, and immune-enhancing features [3].

The apparent association of yoga with increased melatonin activity may be another aspect of its beneficial properties for COVID-19 infection [11], since melatonin plays some role in the treatment of viral infections [42].

Reduction of inflammatory markers and improvement in the activity of the specific immune cells involved in the pathogenesis of COVID-19 are mostly needed [30]. The probable usefulness of yoga in COVID-19 has been inferred from its effects on similar conditions such as acute upper respiratory infections, obstructive lung disorders, and so on [30].

The upper respiratory tract is the entrance for the SARS-CoV-2 virus, therefore the respiratory system health is very important [43]. Yoga practice has been reported as improving chronic obstructive pulmonary disease (COPD) [43], namely through the increase of tolerance to exercise [44]. COVID-19 disease has a high mortality due to lung infection, so yoga can be effective in preventing premature death of COVID-19 related lung infection [45].

Yoga is the oriental practice with the largest body of evidence in favor of potential benefits, either due to a greater volume of studies, or to the fact that it is the mind-body practice more widespread in the West [46]. Even though most studies do not have a very robust body of evidence, yoga seems to be a simple, safe and low-cost therapeutic alternative for quality of life improvement, positively influencing the physiological and biochemical parameters of the practitioners [46]. Yoga can be practiced by anyone, requires no infrastructure, and is a restorative individual activity which can be easily practiced during periods of social isolation such as the ones we have been experiencing with the COVID-19 pandemic [47], namely through sessions in a tele-yoga format [48,49]. Another possibility is the use of mobile applications, such as the Yoga of Immortals, which has been shown to significantly decrease symptoms of depression and anxiety after an 8-week period regular use [50], and to alleviate insomnia [50,51]. A survey conducted in Australia found that the absence of the common benefits of practicing yoga in person, such as social interaction and attending a dedicated space, did not greatly diminish the perceived mood/mental health benefits of the tele-yoga practice [52]. So, yoga may be a simple and advantageous home-based practice for the prevention and post-recovery of COVID-19 [53,54].

In the context of the COVID-19 pandemic, yoga may improve mental health status, immunity against viral infections, systemic health parameters, quality of life, and/or chances of survival in patients with comorbidities [31]. However, the studies published to date are small and are not randomized control trials (RCTs), though RCTs are now being proposed [55]. Some published quasi-randomized controlled or quasi-experimental studies have shown that a yoga intervention can be an effective add-on practice for stress, anxiety, and depression reduction in COVID-19 patients [56,57].

5. How to use yoga for COVID-19 patients

Pranayama, one of the main components of yoga, appears to be a good strategy for these patients, not only for dyspnea relief, but for psychological well-being. Consistent practice of pranayama improves lung function and capacity by strengthening the inspiratory and expiratory muscles [30], increases vital capacity, reduces heart rate, and declines systolic blood pressure [58]. A slow breathing of 6–10 breaths per minute appears to be an “autonomically optimized respiration”, with an increased tidal volume which is achieved through diaphragmatic activation [59]. Breathing difficulty is one of the COVID-19 patients major discomforts; the patients experienced the valuable effects of pranayama in overcoming the breathing difficulty [60].

Anuloma-viloma, one type of pranayama characterized by

alternating breathing through the nostrils, removes minor blockages, balances the flow of breath in both nostrils, and decreases heartbeat and blood pressure [45]. Sudarshan Kriya Yoga (SKY), an advanced controlled cyclic rhythmic breathing technique, is able to augment overall immunity against various microbial, fungal, and viral infections [31]. Since COVID-19 disease has a higher mortality due to lung infection, SKY may prevent premature death in this situation [45].

Bhramari, a pranayama with a prolonged exhalation producing a bee-like buzzing sound, helps to relieve stress and cerebral tension, and to manage depression, anxiety, and insomnia in COVID-19 patients [45]. The humming sound creates a vibration which calms the mind and the nervous system, producing an 8–21-fold increase in nasal nitric oxide comparing with a quiet exhalation [45]. Nitric oxide has an important role in the immune system: as a vasodilator it improves blood flow to the organs, causes an anti-inflammatory action in the arteries, and boosts immune defense promoting the destruction of viruses and other parasitic organisms [45]. Bhramari was reported as having a positive impact on psychological health and on sleep quality of COVID-19 patients during home isolation [61]. The patients were performing 20 min bhramari pranayama online during 15 days [61].

Asana proposed to COVID-19 patients should be easy to perform in order to not cause post-exertion malaise, since fatigue is one of the more common COVID-19 symptoms. Isometric asana have been successfully used for chronic fatigue syndrome (CFS), a condition that shares some features with the post-COVID-19 condition, namely the severe fatigue. Significant fatigue improvement has been reported with isometric asana practice in CFS, supported by alterations in blood biomarkers [62,63].

Meditation has shown to have large effects on several inflammatory markers of COVID-19 patients [64,65] and should be used with standard care treatment in these patients [64,66] to promote general health and well-being [66]. Using meditation, convalescence periods tend to be shorter, and healing from illnesses is quicker [65]. Meditation might enhance neuroplasticity specifically through the mechanisms of relaxation and training of attention [67], allowing COVID-19 patients to better recover from the disease. Mindfulness meditation has potential for treatment of clinical disorders, and might facilitate cultivation of a healthy mind and increased well-being [68].

In India, the Ministry of AYUSH (Ayurveda, Yoga & Naturopathy, Unani, Siddha, and Homeopathy) produced guidelines for post-COVID recovery [69,70], including a yoga protocol focusing on the increase of respiratory and cardiac efficiency, on stress and anxiety reduction, and on immunity enhancement [70]. Marwah and Marwah [71] advise daily sessions of yoga, pranayama and meditation to boost the immune system. Actively promoting mind-body interventions which have shown empirical evidence, such as yoga, might benefit many COVID patients, with a minimal potential for harm [72]. Although more research is certainly needed, there is sufficient rationale, pre-clinical data, and evidence of safety from long-term clinical use of yoga for other common ailments [72].

6. Yoga for COVID 19 burden in non-patients (health workers, lockdown effects, anxiety/fear caused by the pandemic, social isolation)

Healthcare professionals (HCPs) face heavy stress loads [73], particularly in the COVID-19 pandemic context. In fact, according to the Delphi consensus, HCPs continue to experience unaddressed mental issues due to the pandemic [10]. This psycho-physical distress (burnout) compromises the well-being of the workforce and affects patients' health [73].

A yoga intervention may be an important help to achieve a stable psycho-physical well-being in this stressful work environment [73]. HCPs who practiced yoga during the pandemic reported significantly less stress and psychological distress comparing with the ones who did not practice yoga [74,75]. In another study with HCPs, SKY was shown to have a positive impact on their well-being [76]. Participants reported

increased sleep quality, improved satisfaction with life, and higher resilience after SKY [76]. The data reported are important for future multi-site RCTs studying the impact of yoga on HCPs well-being [76]. An RCT conducted to evaluate the effects of laughter yoga in the reduction of perceived stress and burnout levels, and the increase of life satisfaction of nurses, showed that laughter yoga was an effective method [77].

One of the most severely affected age groups due to the prolonged lockdowns are the young adults, especially students [78]. Yoga regular practice has the potential to positively impact students' physiological, emotional, and immunological factors, affecting their wellbeing and academic performance [78]. SKY was shown to reduce the negative impact of the pandemic on the mental health of practitioners compared to non-SKY practitioners, helping fighting insomnia and other psychological disorders in the general population [79].

Home-office workers who performed a 10 min/day yoga practice for 1 month, using a web platform during the lockdown, experienced decrease in discomfort of the eyes, head, neck, upper back, lower back, right wrist, hips/buttocks and mood disturbance, compared to absence of changes, or even worsening of symptoms, in the control group [80].

7. Yoga protocols in the COVID-19 context

Yoga may play a significant role in the psycho-social care and rehabilitation of COVID-19 patients in quarantine and isolation, being particularly useful in relieving their fears and anxiety [81]. The Ministry of AYUSH has provided guidelines for prevention, rehabilitation and to increase immunity, with contraindications for each disorder the patient may be experiencing [81]. Protocols for COVID-patients and non-COVID patients affected by the pandemic are being developed, namely RCTs which are the gold standard for effectiveness research. Singh et al. [82] proposed a RCT to evaluate the use of yoga in ankylosing spondylitis non-COVID-19 patients. The yoga module was developed keeping in mind the COVID-19 pandemic, so the sessions will be delivered online by certified yoga therapists with over five years of experience through e-health modalities (online video classes) [82]. Dhamodhini et al., recently developed yoga protocols for mild and moderate depression, framed with pre-existing textbooks and scientific literature to target specific depression symptoms [82]. Similar to many other yoga protocols, theirs contains asana, pranayama, mudra (hand gestures), meditation, and relaxation techniques [82]. The recommended practice duration for mild and moderate depression was 45 min and experts insisted on daily practice for 12 weeks. Considering the COVID pandemic, the practices can be done online [82].

In an interesting approach for post-COVID-19 condition recovery and for HCPs, Anand et al. performed a RCT to evaluate the efficacy of a yoga-based breathing intervention [83]. Three groups including COVID-19 positive patients, COVID-19 recovered patients, and HCPs, were included. Simple breathing techniques were administered to COVID-positive patients, while both simple breathing techniques and long duration breathing technique were administered to COVID-recovered patients and HCPs [83]. Yogic breathing lowered D-dimer in all yoga groups when compared with controls; the authors suggest that lowering D-dimer by yogic breathing may be helpful in reducing thrombosis and venous thromboembolism in patients with COVID-19 [83]. The findings suggest that the severity of COVID-19 can eventually be modulated by this practice [83].

Yoga protocols may be useful to overcome social isolation, a situation that got worse with the pandemic. Recently, Yoga4Health was implemented by the NHS (UK); it is a pilot yoga intervention developed to be socially prescribed to patients at risk of developing specific health conditions (risk factors for cardiovascular disease, pre-diabetes, anxiety/depression or experiencing social isolation) [84]. A pilot study evaluation of Yoga4Health has shown that it is a highly acceptable intervention to services users, leading to several biopsychosocial improvements, suggesting yoga is an appropriate intervention to provide on social prescription [84].

Considering that the pandemic begun almost three years ago, and that we presently have many patients with different degrees of severity and duration of the post-COVID-19 condition, there is patient availability to implement large-scale RCTs allowing to clearly show yoga interventions effectiveness in this context. In the tested protocols, it will be important to include an active control group, since most studies compare the effect of yoga with a waiting list, not taking into account the placebo effect.

8. Conclusions

The psychological effects of the COVID-19 pandemic are of particular concern, distressing millions of people worldwide who are directly or indirectly affected by the COVID-19 disease. For post-COVID-19 recovery, there are still no general and adequate strategies, due to the multifactorial aspects of this syndrome, and to its novelty.

Mind-body approaches, which have been used as an adjuvant strategy to other ailments, are now beginning to be considered as possible approaches for COVID-19 patients, and HCPs affected by the pandemic. These low-cost and easy to use solutions will be of paramount importance to protect world's population against the associated symptoms of mental ill-health [85].

Yoga in particular, comprising asana, pranayama, and meditation, seems to be especially adequate for COVID-19 recovery, which is a situation characterized by intense fatigue, muscle weakness, dyspnea, and mental health issues. Due to its properties, yoga is being proposed as a strategy of choice.

One of the limitations of the present review is that most information on yoga effectiveness for COVID-19 recovery is derived from studies developed for the evaluation of other health conditions with similar symptoms. This is a consequence of the modernity of the disease, but yoga is already being prescribed for the COVID-19 recovery in countries like India and UK. Another limitation, which encompasses both COVID studies and previous studies with other pathologies, is that many studies are not RCTs, do not include a large number of patients, and do not have an active control group. More research is warranted to show yoga effectiveness for COVID-19 recovery, since currently there are no available treatments, namely to alleviate the mental health burden caused by the disease.

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References

- [1] M. Merad, C.A. Blish, F. Sallusto, A. Iwasaki, The immunology and immunopathology of COVID-19, *Science* 375 (6585) (2022) 1122–1127.
- [2] S. Beyerstedt, E.B. Casaro, É.B. Rangel, COVID-19: angiotensin-converting enzyme 2 (ACE2) expression and tissue susceptibility to SARS-CoV-2 infection, *Eur. J. Clin. Microbiol. Infect. Dis.* 40 (5) (2021) 905–919.
- [3] S. Gautam, R. Dada, Yoga may prevent cytokine storm in COVID-19, *Coronaviruses* 2 (3) (2021) 284–288.
- [4] P. Boaventura, S. Macedo, F. Ribeiro, S. Jaconiano, P. Soares, Post-COVID-19 condition: where are we now? *Life* 12 (4) (2022).
- [5] I.Y.U.T. Committee, COVID-19: A Suggested Recovery Programme from the Iyengar Yoga (UK) Therapy Committee, 2020 [Available from: <https://iyengaryogalondon.co.uk/covid-19-a-suggested-recovery-programme-from-the-iyengar-yog-a-uk-therapy-committee/>].
- [6] P.-C.C. Group, Clinical characteristics with inflammation profiling of long COVID and association with 1-year recovery following hospitalisation in the UK: a prospective observational study, *Lancet Respir. Med.* 10 (8) (2022) 761–775.
- [7] A. Nakamura, T.J. Farrer, A. Liu, Long-term sequelae in young convalescent COVID-19 patients, *Case Rep. Neurol. Med.* (2022) 2022.
- [8] V. Chippa, A. Aleem, F. Anjum, Post Acute Coronavirus (COVID-19) Syndrome, *StatPearls. Treasure Island (FL)*, 2022.

- [9] C. Chen, S.R. Hauptert, L. Zimmermann, X. Shi, L.G. Fritsche, B. Mukherjee, Global prevalence of post COVID-19 condition or long COVID: a meta-analysis and systematic review, *J. Infect. Dis.* 226 (9) (2022) 1593–1607.
- [10] J.V. Lazarus, D. Romero, C.J. Kopka, S.A. Karim, L.J. Abu-Raddad, G. Almeida, et al., A multinational Delphi consensus to end the COVID-19 public health threat, *Nature* 611 (2022) 332–345.
- [11] W. Bushnell, R. Castle, M.A. Williams, K.C. Brouwer, R.E. Tanzi, D. Chopra, et al., Meditation and yoga practices as potential adjunctive treatment of SARS-CoV-2 infection and COVID-19: a brief overview of key subjects, *J. Alternative Compl. Med.* 26 (7) (2020) 547–556.
- [12] P. Boaventura, S. Jaconiano, F. Ribeiro, Yoga and Qigong for health: two sides of the same coin? *Behav. Sci.* 12 (7) (2022).
- [13] B. Hembram, Important of Yoga during Covid-19, 2021.
- [14] I. Basu-Ray, K. Metri, D. Khanra, R. Revankar, K.M. Chinnaiyan, N. Raghuram, et al., A narrative review on yoga: a potential intervention for augmenting immunomodulation and mental health in COVID-19, *BMC Compl. Med. Ther.* 22 (1) (2022) 191.
- [15] M.S. Kulkarni, P. Kakodkar, T.M. Nesari, A.P. Dubewar, Combating the psychological impact of COVID-19 pandemic through yoga: recommendation from an overview, *J. Ayurveda Integr. Med.* 13 (2) (2021), 100433.
- [16] Y.Y. Dhyansky, The Indus valley origin of a yoga practice, *Artibus Asiae* 48 (1/2) (1987) 89–108.
- [17] A.K. Pandurang, M.S. Keshavan, V. Ganapathy, B.N. Gangadhar, Yoga: past and present, *Am. J. Psychiatr.* 174 (1) (2017) 16–17.
- [18] J. Mallinson, M. Singleton, *Roots of Yoga*, Penguin Classics., Milton Keynes, 2017.
- [19] E. De Michelis, *A History of Modern Yoga*, Continuum, 2008.
- [20] P.A. Maas, Sarvastivāda buddhist theories of temporality and the pāṭanjāla yoga theory of transformation (pariṇāma), *J. Indian Philos.* (2020) 1–41.
- [21] G. Feuerstein, *Yoga and Yoga Therapy*, 1998 [Available from: <https://www.iayt.org/page/YogaAndYogaTherapy>].
- [22] S.B. Khalsa, L. Cohen, T. McCall, S. Telles, *The Principles and Practice of Yoga in Health Care*: Pencaitland, Handspring Publishing Limited, 2016.
- [23] N.B. Patel, I. Patnaik, Yoga for COVID - 19, *J. Fam. Med. Prim. Care* 10 (11) (2021) 4336.
- [24] P.E. Jeter, J. Slutsky, N. Singh, S.B. Khalsa, Yoga as a therapeutic intervention: a bibliometric analysis of published research studies from 1967 to 2013, *J. Alternative Compl. Med.* 21 (10) (2015) 586–592.
- [25] T. McCall, *The philosophical basis of yoga therapy*, Available from: <https://www.yogajournal.com/teach/the-philosophical-basis-of-yoga-therapy> 2007 <https://www.yogajournal.com/teach/the-philosophical-basis-of-yoga-therapy>.
- [26] S. Sarbacker, *Tracing the Path of Yoga*, State University of New York Press, 2021.
- [27] S.B. Khalsa, Chapter 17 - yoga as therapeutic intervention, in: W. Lehrer S (Ed.), *Principles and Practice of Stress Management*, The Guilford Press, New York, 2007, pp. 449–462.
- [28] M. Jakubczak, The philosophical foundations of yoga therapy, in: A.T. ZYT (Ed.), *Life the Human Being between Life and Death. Analecta Husserliana (The Yearbook of Phenomenological Research)*, vol. 64, Springer, Dordrecht, 2000.
- [29] H. Nagendra, V. Kumar, S. Mukherjee, Cognitive behavior evaluation based on physiological parameters among young healthy subjects with yoga as intervention, *Comput. Math. Methods Med.* 2015 (2015), 821061.
- [30] C. Umesh, K.K. Ramakrishna, N. Jasti, H. Bhargav, S. Varambally, Role of Ayurveda and Yoga-Based lifestyle in the COVID-19 pandemic - a narrative review, *J. Ayurveda Integr. Med.* 13 (1) (2022), 100493.
- [31] S.A. Zope, R.A. Zope, G.A. Biri, C.S. Zope, Sudarshan kriya yoga: a breath of hope during COVID-19 pandemic, *Int. J. Yoga* 14 (1) (2021) 18–25.
- [32] M. Vajpeyee, S. Tiwari, K. Jain, P. Modi, P. Bhandari, G. Monga, et al., Yoga and music intervention to reduce depression, anxiety, and stress during COVID-19 outbreak on healthcare workers, *Int. J. Soc. Psychiatr.* 68 (4) (2022) 798–807.
- [33] P.R. Pullen, S.H. Nagamia, P.K. Mehta, W.R. Thompson, D. Benardot, R. Hammoud, et al., Effects of yoga on inflammation and exercise capacity in patients with chronic heart failure, *J. Card. Fail.* 14 (5) (2008) 407–413.
- [34] R. Desai, A. Tailor, T. Bhatt, Effects of yoga on brain waves and structural activation: a review, *Compl. Ther. Clin. Pract.* 21 (2) (2015) 112–118.
- [35] R. Govindaraj, S. Karmani, S. Varambally, B.N. Gangadhar, Yoga and physical exercise - a review and comparison, *Int. Rev. Psychiatr.* 28 (3) (2016) 242–253.
- [36] T.V. Danylova, V.M. Shmarhun, A.V. Vertel, B.K. Matyushko, A.F. Bondarenko, T. Kychkyruk, et al., Effects of the eastern mind-body practices on mental health during the covid-19 pandemic: when east meets west, *Wiad. Lek.* 74 (11 cz 1) (2021) 2850–2855.
- [37] R. Rasanika Priyanka, A cross-sectional study of mental wellbeing with practice of yoga and meditation during COVID-19 pandemic, *J. Fam. Med. Prim. Care* 10 (4) (2021) 1576–1581.
- [38] M. Kuppasamy, V. Ramaswamy, P. Shanmugam, P. Ramaswamy, Yoga for children in the new normal - experience sharing, *J. Compl. Integr. Med.* 18 (3) (2021) 637–640.
- [39] Sirsat GJ, Pradhan VS. A Significant Role of Yoga in COVID-19.
- [40] G.J. Tornoczyk, S. Rozsa, H. Nagy, M. Banhidi, Perceived usefulness of yoga to maintain well-being and in relation to COVID-19 cases among Hungarian yoga practitioners, *J. Sports Med. Phys. Fit.* 62 (11) (2022) 1541–1551.
- [41] R.P. Rajkumar, Ayurveda and COVID-19: where psychoneuroimmunology and the meaning response meet, *Brain Behav. Immun.* 87 (2020) 8–9.
- [42] K. Bahrapour Juybari, M.H. Pourhanifeh, A. Hosseinzadeh, K. Hemati, S. Mehrzadi, Melatonin potentials against viral infections including COVID-19: current evidence and new findings, *Virus Res.* 287 (2020), 198108.
- [43] H.R. Nagendra, Yoga for COVID-19, *Int. J. Yoga* 13 (2) (2020) 87–88.
- [44] D.A. Kaminsky, K.K. Guntupalli, J. Lippmann, S.M. Burns, M.A. Brock, J. Skelly, et al., Effect of yoga breathing (pranayama) on exercise tolerance in patients with chronic obstructive pulmonary disease: a randomized, controlled trial, *J. Alternative Compl. Med.* 23 (9) (2017) 696–704.
- [45] R.S. Sawant, B.D. Zinjurke, S.V. Binorkar, Preventive aspect of ayurveda and yoga towards newly emerging disease COVID-19, *J. Compl. Integr. Med.* 18 (4) (2021) 667–678.
- [46] A.D.D. Silveira, R. Stein, Evidence-based alternative therapies that "touch the heart", *Arq. Bras. Cardiol.* 113 (6) (2019) 1059–1061.
- [47] P. Upadhyay, S. Narayanan, T. Khera, L. Kelly, P.A. Mathur, A. Shanker, et al., Perceived stress, resilience, well-being, and COVID 19 response in Isha yoga practitioners compared to matched controls: a research protocol, *Contemp. Clin. Trials Commun.* 22 (2021), 100788.
- [48] N. Jasti, H. Bhargav, S. George, S. Varambally, B.N. Gangadhar, Tele-yoga for stress management: need of the hour during the COVID-19 pandemic and beyond? *Asian J. Psychiatr.* 54 (2020), 102334.
- [49] A. Haynes, H. Gilchrist, J.S. Oliveira, A. Grunseit, C. Sherrington, S. Lord, et al., What helps older people persevere with yoga classes? A realist process evaluation of a COVID-19-affected yoga program for fall prevention, *BMC Publ. Health* 22 (1) (2022) 1–16.
- [50] S. Verma, J. Donovan, H.S. Tunuguntla, R. Tunuguntla, B.V. Gupta, A. Nandi, et al., Yoga of Immortals intervention reduces symptoms of depression, insomnia and anxiety, *Front. Psychiatr.* 12 (2021), 648029.
- [51] R. Tunuguntla, H. Tunuguntla, H. Kathuria, S. Verma, Effectiveness of app-based yoga of Immortals (YOI) intervention for insomnia in Asian population during pandemic restrictions, *Int. J. Environ. Res. Publ. Health* 18 (11) (2021).
- [52] J. Brinsley, M. Smout, K. Davison, Satisfaction with online versus in-person yoga during COVID-19, *J. Alternative Compl. Med.* 27 (10) (2021) 893–896.
- [53] G. Tillu, S. Chaturvedi, A. Chopra, B. Patwardhan, Public health approach of ayurveda and yoga for COVID-19 prophylaxis, *J. Alternative Compl. Med.* 26 (5) (2020) 360–364.
- [54] V. Wadhen, T. Cartwright, Feasibility and outcome of an online streamed yoga intervention on stress and wellbeing of people working from home during COVID-19, *Work* 69 (2) (2021) 331–349.
- [55] B. Yadav, A. Rai, P.S. Mundada, R. Singhal, B.C.S. Rao, R. Rana, et al., Safety and efficacy of Ayurvedic interventions and Yoga on long term effects of COVID-19: a structured summary of a study protocol for a randomized controlled trial, *Trials* 22 (1) (2021) 378.
- [56] R. Jenefer Jerrin, S. Theebika, P. Panneerselvam, S.T. Venkateswaran, N. Manavalan, K. Maheshkumar, Yoga and Naturopathy intervention for reducing anxiety and depression of Covid-19 patients - a pilot study, *Clin. Epidemiol. Glob. Health* 11 (2021), 100800.
- [57] N. Sharma, P.S. Sahni, U.S. Sharma, J. Kumar, R. Garg, Effect of yoga on the stress, anxiety, and depression of COVID-19-positive patients: a quasi-randomized controlled study, *Int. J. Yoga Ther.* 32 (2022) (2022). Article 8.
- [58] S. Singh, V. Gaurav, V. Parkash, Effects of a 6-week nadi-shodhana pranayama training on cardio-pulmonary parameters, *J. Phys. Educ. Sports Manag.* 2 (4) (2011) 44–47.
- [59] M.A. Russo, D.M. Santarelli, D. O'Rourke, The physiological effects of slow breathing in the healthy human, *Breathe* 13 (4) (2017) 298–309.
- [60] N. Kathiresan, R. Arunthathi, V. Venugopal, K. Narayanaswamy, N. Manavalan, K. Maheshkumar, "It is the best part of our Hospital life": A Qualitative analysis on the impact of Yoga and Naturopathy as a Complementary therapy in the management of COVID-19, *Asian J. Psychiatr.* 64 (2021), 102789.
- [61] R.A.R.K. Jagadeesan T, T. Jain, A.R. Allu, G.T. Selvi, et al., Effect of Bhramari Pranayama intervention on stress, anxiety, depression and sleep quality among COVID 19 patients in home isolation, *J. Ayurveda Integr. Med.* (2022), 100596.
- [62] S. Takakura, T. Oka, N. Sudo, Changes in circulating microRNA after recumbent isometric yoga practice by patients with myalgic encephalomyelitis/chronic fatigue syndrome: an explorative pilot study, *Biopsychosoc. Med.* 13 (2019) 29.
- [63] T. Oka, T. Tanahashi, N. Sudo, B. Lkhagvasuren, Y. Yamada, Changes in fatigue, autonomic functions, and blood biomarkers due to sitting isometric yoga in patients with chronic fatigue syndrome, *Biopsychosoc. Med.* 12 (2018) 3.
- [64] R.D. Castle, M.A. Williams, W.C. Bushell, J.A. Rindfleisch, C.T. Peterson, J. Marzolf, et al., Implications for systemic approaches to COVID-19: effect sizes of remdesivir, Tocilizumab, melatonin, vitamin D3, and meditation, *J. Inflamm. Res.* 14 (2021) 4859–4876.
- [65] D. Benson, Conversation with Ashok Gupta, MA (cantab), MSc: treating long-haul covid, *Integr. Med.* 20 (2) (2021) 42–46.
- [66] K. Mahendru, A. Pandit, V. Singh, N. Choudhary, A. Mohan, S. Bhatnagar, Effect of meditation and breathing exercises on the well-being of patients with SARS-CoV-2 infection under institutional isolation: a randomized control trial, *Indian J. Palliat. Care* 27 (4) (2021) 490–494.
- [67] S.M. Skeide, *Meditation and Neuroplasticity*, 2010.
- [68] Y.Y. Tang, B.K. Holzel, M.I. Posner, The neuroscience of mindfulness meditation, *Nat. Rev. Neurosci.* 16 (4) (2015) 213–225.
- [69] A.K. Panda, S. Kar, A.K. Rai, B.C.S. Rao, N. Srikanth, AYUSH- 64: a potential therapeutic agent in COVID-19, *J. Ayurveda Integr. Med.* 13 (2) (2022), 100538.
- [70] R. Kotecha, The journey with COVID-19: initiatives by Ministry of AYUSH, *J. Ayurveda Integr. Med.* 12 (1) (2021) 1.
- [71] A. Marwah, P. Marwah, Coronavirus (COVID-19): a protocol for prevention, treatment and control, *J. Appl. Nat. Sci.* 12 (2) (2020) 119–123.
- [72] S. Chaturvedi, N. Kumar, G. Tillu, S. Deshpande, B. Patwardhan, AYUSH, modern medicine and the Covid-19 pandemic, *Indian J. Med. Ethics* 5 (3) (2020) 191–195.

- [73] R.A. Cocchiara, M. Peruzzo, A. Mannocci, L. Ottolenghi, P. Villari, A. Polimeni, et al., The use of yoga to manage stress and burnout in healthcare workers: a systematic review, *J. Clin. Med.* 8 (3) (2019).
- [74] L. Ollis, P. Shanahan, Stress, psychological distress and support in a health care organization during Covid-19: a cross-sectional study, *J. Nurs. Manag.* 30 (2) (2022) 359–366.
- [75] M. Zhang, B. Murphy, A. Cabanilla, C. Yidi, Physical relaxation for occupational stress in healthcare workers: a systematic review and network meta-analysis of randomized controlled trials, *J. Occup. Health* 63 (1) (2021), e12243.
- [76] K. Divya, S. Bharathi, R. Somya, M.H. Darshan, Impact of a yogic breathing technique on the well-being of healthcare professionals during the COVID-19 pandemic, *Glob. Adv. Health Med.* 10 (2021), 2164956120982956.
- [77] S.C.K.A. Si, T. Kilinc, The effect of laughter yoga on perceived stress, burnout, and life satisfaction in nurses during the pandemic: a randomized controlled trial, *Compl. Ther. Clin. Pract.* 49 (2022), 101637.
- [78] N. Dalpati, S. Jena, S. Jain, P.P. Sarangi, Yoga and meditation, an essential tool to alleviate stress and enhance immunity to emerging infections: a perspective on the effect of COVID-19 pandemic on students, *Brain Behav. Immun. Health* 20 (2022), 100420.
- [79] S. Parimala, D. Kanchibhotla, Association between yogic breathing practice with perceived impact of COVID-19: a cross-sectional study from India, *Asia Pac. J. Publ. Health* 33 (1) (2021) 157–159.
- [80] M.G. Garcia, M. Estrella, A. Penafiel, P.G. Arauz, B.J. Martin, Impact of 10-min daily yoga exercises on physical and mental discomfort of home-office workers during COVID-19, *Hum. Factors* (2021), 187208211045766.
- [81] AYUSH Mo. Guidelines for Yoga Practitioners for COVID 19. AYUSH BHAWAN, B Block, GPO Complex, INA, NEW DELHI - 110023.
- [82] J. Singh, M. Jha, K. Metri, S. Mohanty, A. Singh, P. Tekur, A study protocol for a randomised controlled trial on the efficacy of yoga as an adjuvant therapy for patients with Ankylosing spondylitis amidst COVID-19 pandemic, *Adv. Integr. Med.* 9 (1) (2021) 75–79.
- [83] A. Anand, M. Rain, G.D. Puri, A. Bhalla, P. Avti, B. Subramaniam, et al., Efficacy of yoga-based breathing intervention in COVID-19 positive, post-covid and health care workers: a randomized clinical trial, *Psychosom. Med.* 84 (5) (2022) A7-A.
- [84] A. Cheshire, R. Richards, T. Cartwright, 'Joining a group was inspiring': a qualitative study of service users' experiences of yoga on social prescription, *BMC Compl. Med. Ther.* 22 (1) (2022) 1–15.
- [85] D. Vatansever, S. Wang, B.J. Sahakian, Covid-19 and promising solutions to combat symptoms of stress, anxiety and depression, *Neuropsychopharmacology* 46 (1) (2021) 217–218.