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Role of Ayurveda and Yoga-Based lifestyle in the COVID-19 pandemic – A narrative review

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A B S T R A C T

The COVID-19 pandemic has posed an immense challenge to health care systems around the globe in terms of limited health care facilities and proven medical therapeutics to address the symptoms of the infection. The current health care strategies are primarily focused on either the pathogen or the environmental factors. However, efforts towards strengthening the host immunity are important from public health perspective to prevent the spread of infection and downregulate the potency of the infectious agent. While a vaccine can induce specific immunity in the host, non-specific ways of improving overall host immunity are needed as well. This scenario has paved the way for the use of traditional Indian therapies such as Ayurveda and Yoga. This review aims at collating available evidence on Ayurveda, Yoga, and COVID-19. Further, it draws inferences from recent studies on Yoga and Ayurveda on immunity, respiratory health, and mental health respectively to approximate its probable role in prophylaxis and as an add-on management option for the current pandemic.

1. Introduction

The Coronavirus disease (COVID-19) pandemic has emerged as a major challenge, especially for the health care sector across the globe. Currently, as the number of positive cases of COVID-19 is outstripping existing healthcare facilities, an economically feasible therapeutic option can be immensely beneficial. Strategies that can improve immune surveillance and resilience in terms of reduction in inflammatory markers and improvement in the activity of the specific immune cells involved in the pathogenesis of COVID-19 are the need of the hour. Conti et al. suggested that reduction of inflammatory responses is a relevant strategy to reduce the severity of the COVID-19 disease, that could potentially reduce the number of cases requiring critical care [1]. The current health care strategies have primarily focussed on either the pathogen or on the environmental factors. However, the efforts towards strengthening the host immunity are important from public health perspective to prevent the spread of infection and downregulate the potency of the agent. While a vaccine can induce specific immunity to the host [2], non-specific ways of improving overall host immunity are equally necessary. Thus, traditional Indian systems of medicine such as Ayurveda and Yoga should be explored for their potential role in improving host immunity and reducing severity of the infection.

This review aims to consolidate the existing literature available on Yoga and Ayurveda for COVID-19. Further, it infers the ancilliary evidences for utility of Yoga and Ayurveda in enhancing health in three major domains: 1) Immune system, 2) Respiratory system and 3) Mental health, that are more vulnerable during COVID-19 infection.

2. Understanding COVID-19

2.1. Ayurveda perspective

According to Ayurveda classics, the term Janapadodhwamsa (epidemic diseases) has been used to describe epidemics/pandemics which manifest due to polluted Vayu (air), Bhumi (land), Jala (water), and Kala (vitiated seasons). These are considered to be
consequences of ‘Prañanaradha’ (crime against wisdom) and ‘Adharma’ (Unrighteousness) [3]. Ayurveda classics have described the concept of Sukshmakrimi/bhuta (organisms invisible to the naked eye). The term Bhūtabiṣaṅga (exogenous cause) has been used to describe diseases caused by them [3]. Fever due to Bhūtabiṣaṅga is similar to the conditions explained during the epidemics/pandemics. In the Ayurveda context of epidemic diseases, terms such as Samsargaja and Upsargaja have been used to indicate transmission from infected to the healthy through contact including exhaled air. The modes of spread in transmission from infected to the healthy through contact were experimental studies. Those 18 studies included: 1

3.1. COVID-19 infection current evidence base

Clinical symptoms reported by Huang et al. from heavily affected places of COVID-19 suggests that, 98% patients had mild to moderate fever (Jwara), 76% had cough (Gaska), and 44% had myalgia (Angamardha) and fatigue (Tandra). Among those who developed pneumonia, 99% had fever (Jwara), 70% had fatigue (Tandra), 59% dry cough (Vitakakasa), 40% anorexia (Aruci), 35% had myalgia (Angamardha), 31% had dyspnea (Swasa), and 27% had sputum production (Kaphajakasa) [5]. Considering all these factors, COVID-19 can be considered as a Kapha-vatasamsargajjvāra (a febrile condition with predominance of kapha and vata) [3] with Pitta association [3] in the initial stages. At advanced stages it acquires the status of overt Sannipatājvāra (a febrile condition with predominance of all Tridosha viz., Vata Pitta and Kapha-a disease involving all Tridosha in its pathophysiology) which has been described in Ayurveda as difficult to cure) [3].

2.2. Yoga perspective

Yoga therapy emphasises on modulation of host factors such as regulation and moderation of the lifestyle factors [6]. Host immunity is downregulated due to altered lifestyle patterns such as consumption of unhealthy food, physical inactivity, improper sleep—wake cycle, increase in workload, stress, and addictions [7,8]. This results in fragility of the immune resilience that results in the host succumbing to the virus. Thus, the aim of Ayurveda and Yoga therapeutics is to enhance host immunity and reduce the extent of infection and inflammation in the body by balancing body humors and lifestyle factors.

3. Potential role of Ayurveda and Yoga in COVID-19 infection: current evidence base

To understand the role, we have categorized our literature search into three domains which are commonly involved in COVID-19 infection: 1) Immune system. 2) Respiratory System and 3) Mental Health.

3.1. COVID-19 infection current evidence base

3.1.1. Ayurveda

Using the key words ‘Ayurveda’ and ‘COVID’ in search engine PubMed till 20th December 2020. We found 218 articles; out of these 63 dealt with Ayurveda and COVID-19. From these 63–45 articles were reviews, letters to editor, or concept papers and 18 articles were experimental studies. Those 18 studies included: 1 double blind Randomized controlled trial (RCT), 1 uncontrolled RCT on influenza like illness, 1 prospective open label intervention clinical trial, 2 case studies and 13 were Insilicio/docking studies. Insilicio/Docking studies were conducted on Ayurveda herbs such as Asparagus racemosus, Tinospora cordifolia, Nigella sativa, Withania somnifera, Andrographis paniculate, and Zingiber. Much of the data on anti-viral properties of medicinal herbs come from Insilicio and in-vitro studies. Molecular docking studies suggest that curcumin and nimbin withaferin A, piperine, mangiferin, thebaine, berberine, and andrographolide have significant binding affinity towards spike glycoproteins of SARS-CoV-2 and ACE2 receptor and may be useful as a therapeutic and/or prophylactic agent for restricting viral attachment to the host cells. Resveratrol, quercetin, luteolin, naringenin, zingiberene, and gallic acid have significant binding affinity towards the ACE2 receptor only and therefore may be used for ACE2-mediated attachment inhibition of SARS-CoV-2 [9]. Study with Asparagus racemosus (Willd.) found Asparagus-C, Asparagus-D, and Asparagus –F were most effective against NSP15 Endoribonuclease and spike receptor-binding domain [10]. Further studies demonstrated Berberine, a chemical constituent of T. cordifolia can regulate 3CLpro protein’s function due to its easy inhibition and thus can control viral replication [11]. Among twenty-five phytoconstituents of N. sativa; alpha-spinasterol, beta-sitosterol, campesterol, taraxerol and 24-methylene-cycloartenol showed best binding affinity against N-terminal RNA binding domain of nucleocapsid protein and papain-like protease of SARS-CoV-2 [12]. Docking study with Withania somnifera (Ashwagandha) found four constituents; Withanoside II, Withanoside IV, Withanoside V and Withanoside VI and Sitoindoside IX exhibited potential inhibition against main protein (Mpro) of SARS-CoV-2 [13]. Similar observations were observed with Andrographolide from Andrographis paniculate exhibited potential inhibition against main protein (Mpro) of SARS-CoV-2 [14]. In another docking study 6 gingesulphonic acid which is present in Sunti (Zingiber officinale Roscoe) showed higher binding energy and inhibition to protein molecule of SARS-CoV-2 compared to hydroxychloroquine and quinine [15]. In a prospective clinical study comprising Daśmūlakātrayādi kāṣaya and Guḍuchyādi kvātha tablets as add ons to standard care showed a faster recovery from breathlessness with reduced ageusia accelerating recovery in terms of reduction of symptoms and duration of hospital stay [16].

3.1.2. Yoga

Using the key words “Yoga” or “meditation”, “COVID”, “corona virus”, “SARS” in PubMed search engine, we found 29 articles till December 2020. Out of these, 18 articles were on Yoga and COVID-19, which included: 9 review articles discussing the role of Yoga in the pandemic [17–25], 4 letters to editor and short communications [26–29], 2 research protocols of randomized controlled trials, (first one to study the efficacy of online Sudarshan Kriya Yoga (SKY) for frontline hospital staff) [30] and the other to examine the effect of meditation app on anxiety and wellbeing [31], 2 cross-sectional observational studies [32,33], 2 articles on cancer care during pandemic [34,35], 1 on modifications in tele-training and tele-assessment in alternative therapies for multiple sclerosis during COVID-19 pandemic [36]. From these 18 articles, 3 articles exclusively focused on the role of yoga in elderly [23,27,28] and 2 were related to maternal health during the pandemic times [22,24]. Only 4 articles discussed specific Yoga modules for COVID-19 [17,18,26,27].

We would like to provide the contextual summary of the available reviews primarily focusing on Yoga for COVID-19. A study exploring the patterns of physical activity across genders during the pandemic revealed a significant increase in women opting...
Yoga along with reduction in walking and marching outdoors [33]. Yoga has been considered as one of the home-based activities that can be utilized to improve mental wellbeing amidst the pandemic [25]. Nagendra et al. emphasized on homeostasis at body as well as mind and provided philosophical relevance of Pancha-koshas (five sheaths of existence) and Viparyaya vritti (false/interpretation of a subject) of Patanjali’s Pancha vritti (mental afflictions) and Pratipaksha bhavana (contrary mental attitude recommended in yogic literature) to the current scenario in addition to the evidences suggesting role of Yoga as an add-on in reducing severity of infections and inflammation [19]. In the same context, Nagarathna et al. discussed the challenges posed by the pandemic and the potential areas where Yoga could play its role in prevention and management of COVID-19 such as stress management, improving the respiratory functions and immunity [17]. Another review aimed that highlighting the traditional knowledge from Ayurveda and Yoga to formulate local and systemic prophylactic and therapeutic measures in accordance to the known disease course of the SARS coronavirus 2 (SARS-CoV-2) [20]. Bushell et al. lucidly discussed the probable mechanisms of action of Yoga and meditation in combatting the current pandemic. The local and systemic anti-inflammatory actions of Yoga have been discussed and further warranted an urgent need to investigate these mechanisms in order to validate and potentiate the use of Yoga and meditation as an adjunct therapy for management of COVID-19 [21].

3.1.3. Ongoing trials
Clinical Trial Registry of India (CTRI) has 122 registered trials on COVID-19. Of which, 42 trials were on modern medicine and 67 were registered on traditional systems of medicine. Of 67 trials, 45 were on Ayurveda, 14 on Homeopathy, 8 on Yoga/Siddha/Unani.Thirty-one trials included traditional system of medicine as prophylaxis and the other 36 trials as therapy for mild to moderate cases of COVID-19 [37]. However, results from these registered trials are still awaited.

3.2. Immune system

3.2.1. Ayurveda and immunity
Every individual possesses inherent strength which opposes the manifestation and prevents the re-occurrence of disease. This innate strength is called VyadhiKshamatva in Ayurveda. Genetic, epigenetic and lifestyle of an individual determine this innate strength. Ojas (essence of seven tissue elements) is the chief contributor in sustaining VyadhiKshamatva. Ayurveda concept of immunity is classified as Sahaja (constitutional), Kala (chronobiologic) or YuktiKerta (acquired strength) [38]. Optimum immunity plays a vital role in preventing/minimizing the chances of infection in pandemic like situations. Ayurvedic approach towards promoting immunity includes the use of Rasayana that comprises of proper daily regimens, seasonal regimens and consumption of medicinal herbs that enhance tissue regeneration. Among Rasayana specially Kanyaya Rasayana is taken to increase the longevity and intelligence and Ajiraka rasayana taken on the daily basis helps in optimizing the immune system [4]. Herbs such as Tinospora cordifolia, Embelia officinale, Bacopa monnieri, Curcuma longa, Ocimum tenuiflorum, Terminalia chebula, W. somnifera and Asparagus racemosus are potential immunomodulators [39]. Regular use of these herbs either alone or in form of preparations such as Chavyanprash and Brahmi rasayana helps in immune strengthening and serve as an effective prophylaxis in the management of SARS-COV-2 infection. Swarna bindu prashana (SBP) improves the immunity in infants and children [40].

3.2.2. Yoga and immunity
Out of the literature available on Yoga for COVID-19, there are no experimental studies that have demonstrated improvement in immune parameters of patients with COVID-19. However, there are ancillary evidences that point towards probable role of add-on Yoga therapy in increasing the anti-inflammatory neuro-hormonal substances and thereby reducing in the severity of infection. A RCT compared the effects of 8-week Yoga program and matched moderate intensity exercise and no intervention on the acute respiratory illness severity in individuals above 50 years of age during single flu season. Mean global severity [measured on Wisconsin Upper Respiratory Symptom Survey (WURSS-24)] was lesser in meditation group than the exercise group and was significantly lower when compared to control group [41]. Another study demonstrated that regular practice of integrated Yoga program (joint loosening, sun salutations, breathing practices, Pranayama and relaxation techniques) for a month could boost the immunity and psychological health in patients with HIV [42,43]. Yoga has also been found beneficial as an adjunct to anti-tuberculosis treatment (ATT) in patients with pulmonary tuberculosis by reducing the symptom scores, sputum conversion on microscopy, improvement in the lung capacity, and radiographic pictures [44].
A number of RCTS reported the efficacy of Yoga in regulating inflammatory markers. A recent systematic review of 15 RCTs revealed that the practice of Yoga significantly decreased pro-inflammatory markers such as Interleukins: (IL)-6, IL-1β and Tumor Necrosis Factor (TNF-α) and increased the levels of anti-inflammatory markers such as IL-10 and IL-12 [45]. Further, Davidson et al. (2003) demonstrated an increase in antibody titer in response to influenza vaccine in the subjects who practiced 8-week meditation program as compared to the control non-meditators [46]. Studies have also demonstrated higher levels of circulating CD3+, CD4- and CD8+, B lymphocytes and Natural Killer cells (NK cells) in the meditators and Yoga practitioners as compared to no-practitioners [47–49]. Sudarshan kriya (SK), a yogic breathing which includes Ujjayi and Bhastrika practices has been found to lower blood lactate levels, enhance antioxidant defence [50] and improve NK cell counts [51]. Also, studies have reported that practice of Yoga for 4–12 weeks can improve anti-oxidant status of an individual by improving the levels of glutathione and superoxide dismutase [52,53]. These evidences suggest the role of Yoga in reducing the severity of infections by regulating the immune responses.

3.3. Respiratory System

3.3.1. Ayurveda and respiratory health
SARS-CoV-2 enters the host via the respiratory tract, airway and alveolar epithelial cells, vascular endothelial cells and alveolar macrophages are among their first targets of viral entry. These cells are the initial targets for early infection and subsequent replication due to their expression of ACE2. Observations emulating the disease course of COVID-19, suggesting that the lung is the primary tropism of SARS-CoV-2. From Ayurvedic point of view, the primary site of the disease is Pranavaha srotas, which includes both upper and lower respiratory tracts. Ayurveda mentions several interventions that can improve the innate immunological responses of respiratory epithelium and thus may prevent the virus transmission to lungs. The daily regimen measures such as Usha pana (drinking water retained in copper vessel), gargling, nasal installation and consuming hot food and water may be beneficial in maintaining the respiratory health that plays a key role in host defense mechanism against viral infections [54–56]. Medicated hot water (Shoolaganga paniya) may help in improving digestion and balancing of vāta and kapha dosha which play a major in manifestation of respiratory conditions such as rhinitis, cough, and breathlessness [38].
AYUSH kvatha [57], a Government of India initiative, is an herbal concoction of household spices consisting of holy basil, cinnamon, ginger and black pepper along with jaggery/raisins and lemon juice that may help in restoring the respiratory health. All the ingredients in AYUSH kvatha pacify Kapha and Vata, they possess Kasahara, Svasahara, Depana, Pachana, Jvaragna and Kri-nigama properties [58]. Sodana (bio-cleansing) in form of Ritu sodana (seasonal bio-cleansing) and Rasayana (immune modulat-ors) for the maintenance of respiratory health. Several in-vitro, animal and human clinical studies have demonstrated the immunomodulatory effects of the Rasayana drugs such as Aswagandha (W. somnifera), Gaduci (Tinospora cordifolia) and Anmalaka (Emblica officinalis) [39]. Recent studies on Aswagandha have reported significant increase in immunoglobulins viz. IgA, IgG and IgM [59]. Gaduci has been found to exert a variety of immunomodulatory effects such as stimulation of phagocytic functions, macrophage and mitogenic activity, antibody responses, synthesis of interleukins, and humoral and cell-mediated immunity, both in-vitro and in-vivo respectively [60]. Another study on Anmalaka rasayana (AR) has suggested that it possesses an immuno-stimulant and cytoprotective activity [61].

### 3.3.2. Yoga and respiratory health

Currently, there are no experimental studies that demonstrated improvement in lung functions in patients with COVID-19. We have aimed at drawing evidences from synonymous non-infectious conditions with respiratory distress. Consistent practice of yogic breathing techniques (Pranayama) improves lung functions and capacity by strengthening the inspiratory and expiratory muscles [62]. In a controlled study, the practice of Bhastrika (Bellow’s breath) Pranayama significantly increased the maximum inspira-tory and expiratory pressures in comparison to the stretching ex-ercises in the elderly participants [63]. A randomised, double-blind, placebo-controlled, crossover trial demonstrated improvement in mean forced expiratory volume in 1-s (FEV1), peak expiratory flow rate, symptom score, and inhaler use (over the past 3 days) in 18 patients with mild asthma after the practice of slow deep yogic breathing. The breathing was practiced for 15 min, twice a day, for two consecutive weeks [64]. Similar improvements have been re-port ed in trials involving patients with moderate to severe asthma and Chronic Obstructive Pulmonary Disease (COPD) [65,66]. Chair based Yoga breathing practices have been found useful in acute airway obstruction in patients with bronchial asthma [17]. Soni et al. also reported an improvement in TLCO (Transfer factor of Lung for Carbon Monoxide) diffusion capacity inpatients in the Yoga arm. TLCO improved from 17.61 ± 4.55 to 19.08 ± 5.09 ml/mmHg/min in patients with mild COPD and from 14.99 ± 4.02 to 17.35 ± 3.97 ml/ mmHg/min in patients with moderate COPD, as compared to the control group who were on conventional therapy alone [67]. A study assessed blood oxygen saturation before, during and after two Yoga breathing techniques; high frequency Yoga breathing (Kapalabhati) and breath awareness in 29 healthy young male volunteers. A significant increase in oxygen saturation was noted after high frequency Yoga breathing for 33-min [68]. Another study examining the effect of Humming breath (Bhramaripranayama) reported improvement in sinus ventilation and 15-fold increase in nasal nitric oxide (NO) levels (involved in host defence functions) [69].

### 3.4. Mental health

#### 3.4.1. Ayurveda and mental health

During the current pandemic, Rajkumar et al. reported that 28% of the screened subjects (general public and healthcare professionals) reported stress, symptoms of anxiety, and depression [70]. A meta-analysis of 300 studies concluded that chronic stressors reduce both cell mediated and humoral immunity of the host [7]. On the other hand, reduction in stress hormones, psy-chological stress, anxiety, and depression are associated with better functioning of the immune system. This emphasizes the need for addressing mental health issues during the current pandemic. Both physical and psychological disorders have the capacity to exert mutual effects on each other. Conditions such as fever can exert its effect over mind and can lead to psychological manifestations on other hand physical conditions can lead the physical manifes-tations (ca.vi 6/7). Swasthya (health) in Ayurveda includes mental well-being in the form of Prasanna (healthy), Atma (soul), Manah (mind), and Indriyah (senses) [4]. Caraka has advocated Achara rasayana (code of behavioral conduct) for perfect mental, physical, social, spiritual health of human beings. It includes moral, ethical, and benevolent conduct: truth, nonviolence, personal and public cleanliness, mental and personal hygiene, devotion, compassion, and a yogic lifestyle [3].

A study suggested that individual who strongly follows Achara rasayana were good at academics, enjoying good physical and mental health and friendly reputation among peers [71]. Further acharyas advocated intake of Medhya rasayan (psychotropic Ayurvedic pharmacological interventions) for maintenance of mental health. Medhya rasayan include drugs which help in cognition enhancement and act as brain tonics or rejuvenators e.g., Mendasparni, Medhavi (Centella asiatica), Yasamadhu (Glycerrhiza glabra), Jvaragitikogda (Tinospora cordifolia), Sankhapuspi (Citandra ternacca) [3]. These drugs promote Dhi (Intelect) Dhi (power of self-control), and Speti (memory). Further, M. rasayanas balance Manodosag (humours that control the mind) viz., Rajas (speed) and Tamas (indolence) thereby regulating and promoting healthy mental functions [72]. Another study revealed that consumption of Aswagandha 600 mg/day for 12 weeks led to overall improvement in the general wellbeing, sleep quality and mental alertness of healthy subjects [73]. Meta-analysis on C. asiatica suggested improvement in alertness and reduction in anger outbursts e.g., Manvaskaorini (Centella asiatica), Vastidnudhu (Glycerrhiza glabra), Gaduci (Tinospora cordifolia) and Sankhapuspi (Citandra ternacca) [3]. These drugs promote Dhī (Intelect) Dhī (power of self-control), and Speti (memory). Further, M. rasayanas balance Manodosag (humours that control the mind) viz., Rajas (speed) and Tamas (indolence) thereby regulating and promoting healthy mental functions [72].

### 3.4.2. Yoga and mental health

Mental health plays a pivotal role in regulation of proper im-mune responses and homeostasis.

However, mental health has taken a greater toll in all the sec-ions of the society due to the COVID-19 pandemic [18]. This has resulted in increased incidences of anxiety and depression, leaving the vulnerable population such as healthcare workers at the risk of Post Traumatic Stress Disorder (PTSD) [29]. Yoga has been included as one of the home-based activities to improve mental health during the current pandemic [25]. There are evidences on the ef-ficacy of yoga in previous similar natural disasters [76,77]. There are two studies that have reported improvement in mental health during the current pandemic period. A cross sectional study has reported that higher percentage of non-practitioners (33%) of Sudarshan kriya yoga (SKY) have reported anxiety and negative effects on their mental health that SKY practitioners (17.7%) during the current pandemic [32]. Another, pre-post single group study investigated the effect of tele-yoga intervention on perceived stress. To meet the norms of social distancing during the present pandemic, a tele-yoga module was designed and was offered to the general public during the national lockdown period. The partici-pants were assessed on perceived stress scale (PSS-10), Yoga
Performance Assessment (YPA) and Visual Analog Scale (VAS) at the baseline and after a 4-week Yoga program. Their YPA scores indicated that Yoga practices were learnt properly and efficiently. At the end of 4-weeks, a significant reduction in perceived stress on PSS-10 and improvement in wellbeing on VAS was noted, suggesting usefulness of the tele-yoga module in reducing stress and improving mental wellbeing [26].

Prodigious amount of evidence suggests usefulness of Yoga to induce mental tranquillity and equilibrium. Yoga is known to regulate hypothalamic-pituitary-adrenal (HPA) axis and bring balance in the autonomic nervous system functions. Practicing Yoga increases the Gamma Amino Butyric Acid (GABA) levels and reduces the levels of cortisol (stress hormone) and catecholamines leading to reduction in stress, anxiety, and depression [78,79]. Further, a systematic review that studied 7 RCTs with 240 participants with major depressive disorder reported positive effects of Yoga beyond placebo concluded that Yoga interventions were comparable to other evidence-based conventional interventions [80]. Similarly, systematic review including RCTs on anxiety disorders and individuals with elevated levels of anxiety revealed that Yoga is safe and effective for elevated levels of anxiety, however future studies to conclude its efficacy for anxiety disorders are required. Recent systematic reviews studying the effects of Yoga in stress in healthy individuals and healthcare workers suggested positive effects of Yoga on reducing stress [81,82].

4. Discussion

4.1. Critical analysis of literature

As narrated above, current available literature in Yoga and Ayurveda has lucid theoretical framework that could be used as foundation for the experimental studies to examine their effects for COVID-19 infection in the domains of improving immunity, reducing respiratory distress, and improving mental health. Recommendations and probable usefulness of Yoga and Ayurveda in COVID-19 in the existing literature have been extrapolated from its effects on other similar conditions such as acute upper respiratory infections, obstructive lung disorders, and so on. Though some case-studies and small pilot experimental studies have been published, experimental studies with robust methodology and validated intervention protocols on humans are lacking and are warranted in future. Scientific rigour should be followed to ascertain the efficacy of such interventions.

4.2. Probable mechanisms of action

4.2.1. Ayurveda

With a view point of prevention and improving the host defence mechanism when the contact of the pathogen with the host is unavoidable the above narrated measures helps to overcome/minimize the severity of the infection. Rasayana dravyas may stimulate humoral immunity in terms of antibody production and cell-mediated immunity in terms of delayed-type hypersensitivity [39]. They may diminish the release of TNFα, IL-1, inhibit NF-kB, increase B cell proliferation, and act by chain breaking and scavenging of free radicles [83]. Study has suggested that Swarna bindu prashna may enhance differentiation immature dendritic cells into mature dendritic cells through expression of CD83 and CD86 which may effectively strengthen the immune system [40]. Copper impregnated water has been found to have antimicrobial, antioxidant, anti-carcinogenic, and anti-inflammatory properties [54]. Mouth rinsing with warm liquids and medicated oil may help in excretion of toxic heavy metals by saliva, may activate salivary enzymes, thus detoxifying the entire body [55]. Nasal installation of medicated oils and vegetable oils such as sesame oil may act as protective layer and trap virus particles thereby preventing direct contact and binding of virus onto the surface of nasal mucosa [56]. Ingredients of AYUSH kvatha possess antiviral, anti-inflammatory and antioxidant properties. Active constituents of these drugs like eugenol, linoelie acid in holy basil, cinnamaldehde in cinnamon, gingerols, shogaols in ginger and piperine in pepper scan have been found to downregulate the proinflammatory pathways thereby decreasing INF-γ. IL-4 and exerting anti-atherosclerotic, anti-coagulative, and anti-platelet activity [57].

4.2.2. Yoga

Yogic practices (particularly Prāṇayāma and meditation) have exhibited significant immunomodulatory effects such as increase in production of immunoglobulins, activation of phagocytic functions, enhancement in humoral and cell-mediated immunity [46–48,51]. It has also been found to reduce inflammatory cytokines such as IL-6, IL-1b, TNF-a (which are part of the ‘cytokine storm’ reported in COVID-19), along with that it also shows to improvement in the levels of anti-inflammatory cytokines (IL-10 and IL-12) and antioxidant status of individuals [41,48,49]. Yoga induces neuro-hormonal modulation via HPA axis resulting in reduction of cortisol levels and balance in sympathetic and parasympathetic nervous system. Further, the practice of Yoga increases GABA levels stimulating the vagus nerve resulting in parasympathetic pre-dominance and optimization of proper immune responses [78,84]. Psychological stress, anxiety and deterioration of sleep quality have increased during the pandemic [18]. These symptoms may be downregulated by the promotive effects of Yoga on melatonin secretion [85]. Melatonin is a known anti-oxidant that plays an important role in improving sleep quality and ameliorating stress and anxiety. Yogic breathing techniques have also been found useful in improving lung functions in conditions with respiratory distress such as COPD and bronchial asthma [65,66], suggesting a probable role in reducing respiratory distress in patients with COVID-19 infection.

The available literature points towards potential role of Ayurveda and Yoga in the prevention of COVID-19 infection, reduction in the intensity of the symptoms, of infection in those afflicted, as well as improving pulmonary function, quality of life, and mental wellbeing in the rehabilitative phase post-COVID.

4.3. Limitations of current literature review

This narrative review has not been systematised according to the PRISMA guidelines of reporting studies due to scanty literature available on the effect of Yoga and Ayurveda for COVID-19. The above suggestions have been drawn based on the efficacy of yogic practices and Ayurvedic drugs as preventive and therapeutic measures in condition bearing similar clinical features.

4.4. Future directions

Collaborative multi-centric trials to evaluate the safety, feasibility and, efficacy of Ayurveda and Yoga lifestyle interventions in treating various stages and severity of the COVID-19 infection are the need of the hour. This will enable recommendation of specific Ayurveda and Yoga protocols for each stage of the illness.

5. Conclusion

Though conclusive evidences on role of Yoga and Ayurveda on COVID-19 are lacking. The available ancillary evidences point towards the potential role of Yoga and Ayurveda in preventing and mitigating the infection through modulating our immune system,
strengthening respiratory system, and mental health respectively. This suggests an urgent need for conducting systematic clinical trials to investigate the add-on efficacy of Yoga and Ayurveda life-style interventions with current conventional treatment approaches.

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Conflict of interest

None.

Author contributions

Chikhnna Umesh: Conceptualisation, Investigation, Data curation, Writing-original draft, Visualization. Kishore Kumar Ramakrishna: Conceptualisation, Methodology, Validation, Data curation, Writing-review & editing, Visualization, Supervision. Nishitha Jasti: Conceptualisation, Investigation, Data curation, Writing-original draft, Visualization. Shivarana Varma: Conceptualisation, Validation, Writing-review & editing, Visualization, Supervision.

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