

A Perspective on Yoga as a Preventive Strategy for Coronavirus Disease 2019

Abstract

The pandemic outbreak of coronavirus disease 2019 (COVID-19) infection caused by severe acute respiratory syndrome-coronavirus 2 has led to profound public health crisis. In particular, individuals with preexisting conditions of heart disease, diabetes, cerebrovascular diseases and the elderly are most vulnerable to succumb to this infection. The current COVID-19 emergency calls for rapid development of potential prevention and management strategies against this virus-mediated disease. There is a plethora of evidence that supports the add-on benefits of yoga in stress management, as well as prevention and management of chronic noncommunicable diseases. There are some studies on the effect of yoga in communicable diseases as well but very few for acute conditions and almost none for the rapidly spreading infections resulting in pandemics. Based on the available scientific evidences on yoga in improving respiratory and immune functions, we have formulated very simple doable integrated yoga modules in the form of videos to be practiced for prevention of the disease by children, adults, and the elderly.

Keywords: Coronavirus disease 2019, immune function, yoga

Introduction

The current outbreak of coronavirus disease 2019 (COVID-19) is an infection caused by severe acute respiratory syndrome-coronavirus 2 (SARS-CoV-2)^[1-10] with the recently analyzed mortality of 5.7% (95% CI 5.5–5.9)^[5] The initial reports of disease outbreak were reported in Wuhan, Hubei Province of China, COVID-19 followed by its worldwide expansion^[3,6,7] owing to the highly contagious nature of the virus. In a meeting on January 30, 2020, as per the International Health Regulations (2005), the WHO declared the outbreak as a Public Health Emergency of International Concern as it has spread across 18 countries across the globe with four countries reporting human-to-human transmission.^[8]

Phylogenetic analysis has indicated a zoonotic origin of SARS-CoV-2,^[6] with person-to-person transmissibility.^[10] SARS-CoV-2 is a β -CoV with highly identical genome to bat CoV, pointing to bat as the natural host.^[9,11] CoVs belong to a large family of single-stranded RNA viruses (+) with a broad distribution

across humans, other mammals, and birds and cause respiratory, enteric, hepatic, and neurologic infections.^[7] These RNA viruses derive their name due to the crown-like or coronal appearance (*corona* is the Latin term for crown) given by the club-shaped glycoprotein spikes in the envelope. Importantly, the past two decades have witnessed the emergence of three highly pathogenic, novel zoonotic CoVs – SARS-CoV (SARS-CoV now named SARS-CoV-1) discovered in November 2002, Middle East respiratory syndrome (MERS)-CoV (MERS-CoV) in June 2012, and SARS-CoV-2, identified in December 2019 – and have been of global public health concerns.^[2,7] These periodic emergencies occur due to frequent cross-species infections and increasing interfaces between humans and other animal interface.^[7,12] These frequent emergences also derive from the high prevalence and wide distribution of CoVs, their large genetic diversity, and frequent recombination of their genomes.^[12]

SARS-CoV-2 causes a respiratory viral infection that represents the most prevalent and pathogenic forms of communicable infectious diseases.^[6,13] In severe cases,

This is an open access journal, and articles are distributed under the terms of the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 License, which allows others to remix, tweak, and build upon the work non-commercially, as long as appropriate credit is given and the new creations are licensed under the identical terms.

For reprints contact: reprints@medknow.com

How to cite this article: Nagarathna R, Nagendra HR, Majumdar V. A perspective on yoga as a preventive strategy for coronavirus disease 2019. *Int J Yoga* 2020;13:89-98.

Submitted: 24-Mar-2020 **Revised:** 29-Mar-2020.
Accepted: 01-Apr-2020 **Published:** 01-May-2020.

R Nagarathna¹,
HR Nagendra²,
Vijaya Majumdar²

¹Vivekananda Yoga

Anusandhana Samsthana,

²Division of Yoga and Life

Sciences, Swami Vivekananda

Yoga Anusandhana Samsthana,

Bengaluru, Karnataka, India

Address for correspondence:

Dr. Vijaya Majumdar,

Division of Life Sciences,

Syvasya University,

Bengaluru - 560 105,

Karnataka, India.

E-mail: majumdar.vijaya@gmail.com

Access this article online

Website: www.ijoy.org.in

DOI: 10.4103/ijoy.IJOY_22_20

Quick Response Code:



wherein there is a delay or absence of early and effective antiviral treatment, the infection could manifest in a compromised systemic and local respiratory defense mechanisms leading to bacterial coinfection culminating into severe acute respiratory illness and occasionally into acute respiratory distress syndrome (ARDS).^[7-9] The current estimates indicate a basic reproduction number (R_0) of 2.2, implying that on an average, each infected person spreads the infection to an additional two persons.^[14]

The latest updates suggest that the pandemic of COVID-19 has entered a new stage with rapid spread in countries outside China indicating the need of practicing the measures for self-protection toward the prevention of transmission of the infection to others.^[4] As of March 16, 2020, a drastic escalation in the number of cases of COVID-19 was observed outside China with a number of 143 affected countries, states, or territories reporting infections to the WHO.^[15] The COVID-19 outbreak is an indication of the prevailing challenge of the recurrent surfacing of the unprecedented pathogenic infections that demand regular monitoring and preparedness.^[14] There is an urgent need of basic and clinical research efforts to aid in the understanding of the disease biology and development of robust combat measures.^[14]

Clinical Course of Coronavirus Disease 2019

SARS-CoV-2 primarily spreads by droplets, and is postulated to have higher transmissibility as compared to seasonal influenza. A major concern arises due to its likely spread via even asymptomatic or minimally symptomatic individuals who may not seek any clinical evaluation.^[16] As reported by Huang *et al.*, patients with COVID-19 primarily present with fever, fatigue, and dry cough.^[17] Most of the patients exhibit favorable prognosis, however, older patients and those with chronic underlying conditions may present with worse outcomes.^[17,18] In the early stages of infection, patients could be afebrile represented with only chills and respiratory symptoms.^[19] The clinical spectrum varies from asymptomatic or mild symptomatic forms to severe forms characterized by respiratory failure that necessitates mechanical ventilation and support in an intensive care unit (ICU) or multi-organ and systemic manifestations in terms of sepsis, septic shock, and multiple organ dysfunction syndromes.^[8]

Challenges toward the Combat of Coronavirus Disease 2019

Effective prevention or treatment of COVID-19 remains a top priority toward the curtailing of this pandemic. Implementation of several infection control measures (e.g., social isolation, distancing, or quarantine of entire communities) have been posited for control and prevention of the COVID-19 outbreak.^[4,20] The most important and effective challenge seems to establish preventive intervening strategies before the human–pathogen interface. Vaccination is the one of the most radical

countermeasures to combat an infectious disease epidemic. Although substantial progress has been made toward characterization of the causative virus for COVID-19, a time period of probably a least 1 year to 18 months has been speculated for substantial vaccine production.^[21] In the early stage of the pandemic, antiviral treatment is the most effective method. Very recently hydroxychloroquine has been reported to be apparently effective against the treatment of COVID-19-associated pneumonia in clinical studies.^[22,23] However, implementation of antiviral treatment and prophylaxis has several requirements, in particular an adequate stockpile of drugs along with the safety of the treatment and cost-effectiveness.^[24] Most importantly, the preventive/controlling measures should be implemented in a judicious and cost-effective manner.^[24]

Integrated Yoga for the Management of Noncommunicable Clinical Conditions

Yoga, an ancient mind–body technique, is defined as samatvam (balance/equipoise/homeostasis) at both mind and body levels to be achieved through mastery over the modifications of the mind (chittavrittinirodhah). The available evidence indicates that yoga/meditation facilitates the coordination among the set of homeostatic responses involving the interaction among the nervous, endocrine, and immune systems.^[25] Hence, the recent definition of yoga states it as a comprehensive skill set of synergistic process tools that aids in bidirectional feedback and modulation of autonomic nervous system outputs through integration between central nervous system (CNS) and afferent and re-afferent inputs from interoceptive processes such as the somatosensory, viscerosensory, and chemosensory.^[25] Postures (Sanskrit: asana), breath regulation (Sanskrit: pranayama), and meditation along with the conceptual corrections comprise the integrative system of yoga techniques that could promote physical as well as mental well-being. The postures or asanas are purported to have different effects. Some are stimulatory to the nervous and circulatory systems, some develop coordination and concentration, while others have a calming effect on the body. Some postures such as the corpse pose are used for elongated periods of relaxation.

Clinically, these therapeutic techniques of yoga have been reported to be beneficial against the management of acute stress as in posttraumatic stress disorder after tsunami^[26] or in chronically stressed people with depression or anxiety^[26-28] and in many noncommunicable diseases such as asthma,^[29,30] hypertension,^[31,32] heart disease,^[33] and diabetes.^[34-38] In particular, yoga has been repeatedly reported to facilitate the attainment of glycemic control and mitigate the influence of other risk factors associated with the complications in patients with diabetes as compared to control conditions. It has been proposed that the abdominal pressure created during exhalation in Kapalabhati improves the efficiency of β -cells of the pancreas.^[35] It can be further

viewed as modulated interoception or sensory modulation evoked by the vigorous practice of Kapalabhati aids in the increased interoception of the abnormal glycemic control that is signaled through the sensory inputs of the CNS that in turn modulates the autonomic outputs to the pancreas and other organs related to disease pathophysiology.

Insights from Clinical Evidence on Efficacy of Yoga/Meditation against Communicable Disease Settings

There is evidence for the beneficial effects of yoga as an add-on strategy for the management of communicable diseases including influenza,^[39,40] tuberculosis (TB),^[41] and human immunodeficiency virus (HIV) infection,^[42-44] wherein status of immune system is an important factor that determines the progression of the disease. The results from the Meditation or Exercise for Preventing Acute Respiratory Illness Trial (MEPARI) trial indicated that training in meditation evoked a larger reduction in global acute respiratory infection (ARI) severity as compared to exercise or the wait-list control participants.^[39,40] The findings of the study were found to be in concordance with prior literature on beneficial effects of moderate-intensity exercise against immune system and reduction in the incidence of ARI illness.^[39]

Similarly, a prospective, randomized trial compared the efficacy of two programs (yoga and breath awareness) as an add-on to anti-TB treatment in sputum-positive cases in a sanatorium in Bangalore.^[41] A total of 1009 pulmonary TB patients were screened and 73 were alternately allocated to yoga ($n = 36$) or breath awareness ($n = 37$) groups. At the end of 2 months, the yoga group showed a significantly better reduction in symptom score and an increase in weight and lung capacity with an improved level of infection control and radiographic image as compared to the nonyoga group.

Effect of 1 month of integrated yoga (IY) intervention has reported to significant improvement in the psychological states as well as in the viral loads in patients suffering from HIV-1 infection.^[42] Further, yoga has also been reported to be an effective intervention for stress management and improvement in psychological health among HIV/AIDS patients.^[42-44] These findings indicate toward a potential complementary role for yoga in the management of communicable diseases.

Yoga for the alleviation of stress induced immune deregulation and strengthening of innate immune response-Paradigm for Viral Infections

Immunity of the host is an essential requisite to facilitate the eradication of infections. Impaired immunity characterized by lymphopenia and elevated CRP levels is an essential clinical feature of COVID-19.^[19] Frequent representation of elderly individuals in the COVID-19-infected cases indicates the plausible role of immunosenescence underlying their

vulnerability to the infection. The severity and outcome of the viral infection could be either an outcome of an effective cellular/innate immune response that combats SARS-CoV-2 as observed in the patients with mild clinical signs of infection or a state of immunosuppression that debilitates and sometimes overwhelms the host's defense.^[2] Available evidence indicates that stress modulates immune competence through immunosuppression^[45] (latency of herpesvirus as represented by the antibody titers), upper respiratory tract infection, and wound healing time, indicating that stress causes a significant immune response dysfunction. Both acute and chronic stressors can mediate their effects on sympathetic nervous system and the hypothalamic-pituitary-adrenal (HPA) axis, thereby impairing antiviral immune responses and innate immunity and deregulation of different immune parameters, primarily the inflammatory pathways.^[46,47] Fear, uncertainty, and stigmatization are psychological stress factors during public health emergencies such as COVID-19.^[48] These factors hinder appropriate medical and mental health interventions and could serve as psychological risk factors and alter the immune function of subjects in quarantine or health-care workers. In the context of pandemics with individuals experiencing high levels of psychological stress, the modulation of HPA axis through practice of yoga could alleviate stress and could aid in the strengthening of the antiviral immune responses.

Innate immunity is needed for precise regulation to eliminate the virus, otherwise will result in immunopathology. A randomized controlled study in nonstressed young healthy students showed a significant increase in interferon-gamma (IFN- γ) levels (a central regulator of cell-mediated immunity, having antiviral, immune-regulatory functions) in the yoga group as compared to students who did not do yoga.^[49] On the contrary, a study by Gopal *et al.*^[50] on students with examination stress showed a significant reduction in the levels of IFN- γ levels after yoga as compared to the nonyoga control group. (Academic stress, the stressful condition of students taking examination, has been proposed to be considered as a more appropriate model of naturalistic stress in human beings as compared with laboratory-induced stress situations). These physiological aspects of yoga-based mechanisms indicate toward the buffering effect of the yoga that aids in restoring the imbalance characterized by either suboptimum or excessive expression of immune responses. Based on its ability to induce and precisely regulate the IFN- γ levels, yoga could boost innate immune responses during the incubation and nonsevere stages to eliminate the virus.^[51] Interestingly, these preliminary observations point to the phenomenon of samatvam or shift toward homeostasis by the holistic approach of IY on the human immune system and all other physiological functions. Further, practice of yoga has been associated with increased immune surveillance

in terms of the modulation of the frequency of blood lymphocytes.^[46] Infante *et al.* reported that in transcendental meditation (TM) practitioners, count of CD3+CD4-CD8+ lymphocytes ($P < 0.05$), B-lymphocytes ($P < 0.01$), and natural killer (NK) cells ($P < 0.01$) was higher as compared to the control group.^[52] Kamei *et al.* reported a significant correlation between the frontal alpha wave activation and the increase in NK activity during yoga exercises.^[53] NK cells are innate lymphocytes that serve as the first line of defense against invading viruses limiting their spread and subsequent tissue damage. Further, Tooley *et al.* reported significantly higher plasma melatonin levels in mediators practicing TM-Sidhi.^[54] Melatonin is known to regulate cellular as well as humoral immunity and stimulates the production of NK cells. A study on 96 women with breast cancer, who participated in a MBSR program for 8 weeks, showed restoration of their NK cell activity and IFN- γ levels as compared to continued deregulation in the non-MBSR group.^[55] In addition, postyoga increases in IgA (an antibody isotype central to mediating mucosal immunity) in pregnant women support the protective potential of yoga against invading pathogens.^[56] As mentioned above, the immunity scores (CD4 counts) of HIV patients have been reported to improve with yoga practice.^[42] Overall, these studies indicate that practice of yoga might strengthen cell-mediated or mucosal immunity and could be used as a preventive measure against virus or other pathogen-mediated infections.

Yoga for alleviation of erratic immune responses

The available evidence supports the potential of yoga as a complementary intervention for populations at risk or already suffering from diseases with an inflammatory component.^[46] Several evidences indicate that yoga might influence chronic inflammatory state and might optimize impaired immune function in stress-induced conditions.^[46] The available evidence also uniformly supports that yoga practice could downregulate pro-inflammatory markers. Among its influence on pro-inflammatory markers, significant decreases in interleukin-1 (IL-1) beta, as well as indications for reductions in IL-6 and tumor necrosis factor (TNF)-alpha, have been indicated.^[46] Cytokine storm represented by increased cytokine levels (IL-6, IL-10, and TNF- α), lymphopenia (in CD4⁺ and CD8⁺ T-cells), and decreased IFN- γ expression in CD4⁺ T-cells is associated with severe COVID-19.^[57] These findings support the utility of yoga as a complementary intervention for populations at risk or already suffering from COVID-19. Duration of the yoga intervention could significantly influence the effects of yoga practice on inflammatory markers. Based on the findings of Pullen *et al.*,^[33] in populations with a high risk of increased inflammation such as heart failure, shorter course of interventions of only 8 weeks has been suggested to be sufficient to reduce inflammatory processes. The authors have indicated that a reciprocal influence of duration of intervention

required depends on the severity or deviation from normal physiology.^[33]

Integrated Yoga for the Management of Coronavirus Disease 2019 with Comorbidities

Respiratory tract infections are highly prevalent in patients with diabetes as compared to those without diabetes.^[58] Extending on the same note, prevalence of diabetes has also been reported to be one of the most distinctive comorbidities in patients with COVID-19; in the study by Xiaobo Yang *et al.* 22% of the non-survivor critically ill COVID-19 patients were reported to have diabetes.^[59] This highly prevalent association between diabetes and COVID-19 could be attributed to the compromised immune function, reduced T-cell response, reduced neutrophil function, and disorders of humoral immunity.^[58] Further, the hyperglycemic environment in these patients could also increase the virulence of pathogens, lower the production of interleukins in response to infection, with reduced chemotaxis and phagocytic activity, and immobilization of polymorphonuclear leukocytes.^[58] As mentioned above, fear, uncertainty, and stigmatization are psychological stress factors during public health emergencies such as COVID-19.^[48] The stress-induced activation of the HPA axis could also significantly contribute to poor glycemic control (hyperglycemia),^[35] thereby exacerbating the clinical symptoms. The stress-reducing aspects of yoga through modulation of HPA axis in patients with aberrant glycemic control (diabetes and prediabetes) could aid in the attainment of glycemic control as has been frequently reported.^[34-38] The practice of yoga might aid in reducing the exacerbations and clearance of virus infection in COVID-19 patients with diabetes through reducing the influence of systemic hyperglycemic and inflammatory milieu.

Similarly, hypertension is also a distinct comorbidity of COVID-19 infection.^[60] A study by Guan *et al.* on 1099 patients with confirmed COVID-19 reported the high prevalence of comorbidities of hypertension (23.7%) and diabetes mellitus (16.2%) in 173 severe cases.^[60] Hypertension is typically treated with drug inhibitors that target the renin-angiotensin system (RAS).^[18,61] These drugs are mainly the angiotensin-converting enzyme inhibitors (ACEIs) or angiotensin receptor blockers (ARBs). These RAS inhibitors have been well established against the effective management of blood pressure (BP) as well as protection from disease-associated inflammation. However, RAS inhibitors have been postulated to affect the expression of ACE2 mRNA and the activity of ACE2 in tissues.^[18,61] ACE2 is a key counterregulatory enzyme of ACE that degrades angiotensin II to angiotensin-(1-7), thereby attenuating the effects on vasoconstriction, sodium retention, and fibrosis,^[62] although there have been no definitive conclusions regarding the association of COVID-19 with RAS inhibitors. ACE2 has been proposed

to be a likely cellular receptor of COVID-19,^[62] and *in vitro* findings have been reported that the receptor mediates the entry of COVID-19 virus into HeLa cells.^[63] Further long-term use of ACEIs might suppress the adaptive immune response, which is a key defense against viral infection.^[61]

Yoga and meditation, in particular slow deep breathing, have been reported to decrease sympathetic nervous system activity, and increase the baroreflex sensitivity in hypertensive patients, thereby reducing their blood pressure values.^[64] Modulation of HPA axis and autonomic outputs including BP has also been reported to underlie its physiological effects of yoga.^[64] However, there has been a lack of evidence on specific targeting of RAS or its effector components through yoga. Inflammatory systematic milieu in hypertensive patients with already altered autonomic regulations could exacerbate disease outcomes. Based on the anti-inflammatory potential of yoga in hyperinflammatory settings such as hypertension, we further extend that yoga could reduce the clinical unfavorable outcomes in hypertensive patients. Further, a Class II-A level of Evidence B recommendation for BP-lowering efficacy has been conferred on slow breathing.^[65] Hence, yoga/slow breathing techniques could provide a safe adjunct/complementary approach for the management of hypertension in COVID-19 patients with hypertension.

Yoga for Better Respiratory Capacity

There is a plethora of evidence that breathing exercises have beneficial effects on the respiratory system.^[66] Pranayama, a yoga-based respiratory exercise, is a simple and cost-effective intervention that could be easily integrated in daily routine and has been proven beneficial in subjects across different age groups including the elderly.^[67] Yoga training has been reported to improve strength of expiratory as well as inspiratory muscles.^[68] Joshi *et al.* reported beneficial effects of a 6-week course of pranayama on ventilatory lung functions.^[69] The authors reported improved ventilatory functions with respect to lowered respiratory rate (RR) and increased forced vital capacity (FVC), forced expiratory volume at the end of 1st s (FEV1%), maximum voluntary ventilation (MVV), peak expiratory flow rate (PEFR), and prolongation of breath-holding time.^[69] Repeated practice of pranayama has been shown to strengthen cardiorespiratory coupling and increases in the parasympathetic activity in healthy individuals.^[64] The breathing practice called Kapalabhati is comprised of powerful strokes of exhalations accompanied with the contraction of abdominal and diaphragmatic muscles followed by passive inhalations.^[70] Kapalabhati aids in appropriate training and toning of diaphragm and abdominal muscles. It also helps in removal of secretions from bronchial tree, cleansing up respiratory passages and the alveoli.^[70] A combination of yogic breathing techniques

improved the pulmonary functions in competitive swimmers.^[71]

Yoga Practice and Chronic and Acute Respiratory Distress

There have been several reports of clinical trials that suggest an overall effect of yoga training toward improved pulmonary function in patients with chronic obstructive pulmonary disease (COPD),^[72-77] an important cause of morbidity and mortality, and poses a major public health problem. When meta-analyzed, a significant clinical effect of yoga in COPD patients with respect to FEV1 was observed.^[72] In addition, the studies reported training effects of yoga on improved exercise capacity, lung function decline, quality of life, and dyspnea in patients with COPD.^[72] Several mechanistic factors have proposed to underlie the beneficial effects seen in the patients undergoing yoga such as increasing respiratory stamina, relaxing chest muscles, expanding the lungs, raising energy levels, and calming the body.^[72] However, due to the lack of adequate data and insufficient clinical evidence provided by these studies, the clinical relevance of these findings needs further thorough robust experimental evaluations.^[72]

Findings of Meditation or Exercise for Preventing Acute Respiratory Illness Trial – Paradigm for viral-mediated respiratory infections

There has been a dearth of clinical evidence on influence of yoga against acute respiratory distress. However, there have been two major relevant successive reports of MEPARI trials that tested the effect of training in mindfulness-based stress reduction (MBSR) or sustained moderate-intensity exercise on incidence, duration, severity, and impact of all-cause mortality of ARI.^[39,40] MEPARI-1 reported statistically and clinically significant reductions in ARI illness for participants randomly assigned to 8 weeks of MBSR training, compared to the observational controls. The MEPARI-2 trial was designed to replicate and extend findings from the first MEPARI trial.^[40] The authors reported a consistent pattern of benefits across the two trials suggestive of preventive effects ranging from 14% to 33% proportional reductions in ARI illness.^[40] Very importantly, the authors presented a comparative perspective of the findings of MEPARI trials against vaccinations against influenza.^[40] Flu shots or vaccines are known to reduce influenza, with published estimates of proportional reductions in symptomatic illness, medical visits, and absenteeism ranging from 13% to 70%.^[78-82] The authors Vaccinations are disease specific; in other words, these are specific to virus strains, so the protection provided is also specific and restrictive. However, mindfulness and exercise trainings have more generic mechanisms, regardless of etiological agent. A recent study has reported beneficial effect of meditation on adaptation to the hypoxic high altitude conditions that requires synergistic functioning of respiratory, cardiac, and hematological

system.^[83] The authors reported increase in the partial pressure of oxygen, (PO₂) a marker of bio-availability of oxygen at the cellular levels.^[83]

Pilot study on yoga module in coronavirus disease 2019

Breathing exercises using the concepts of yoga could also be adopted to help during states of acute respiratory

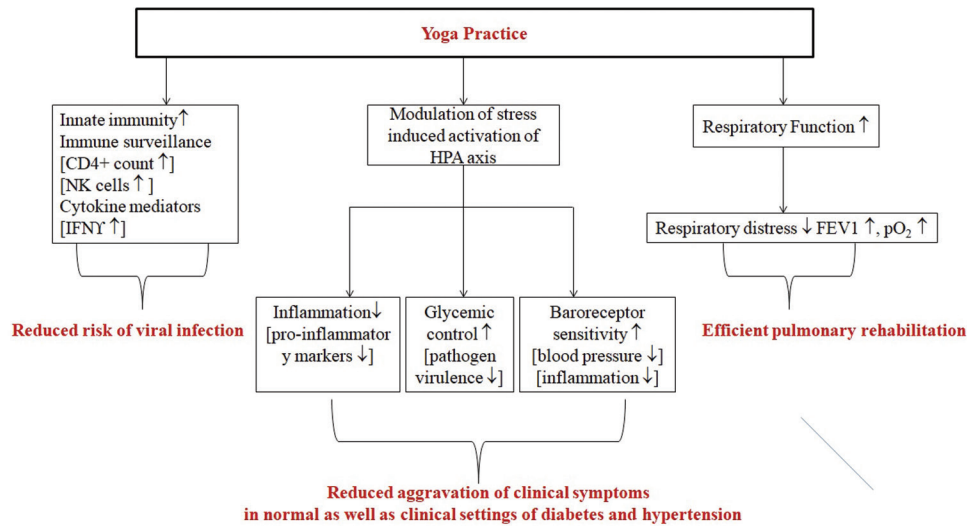



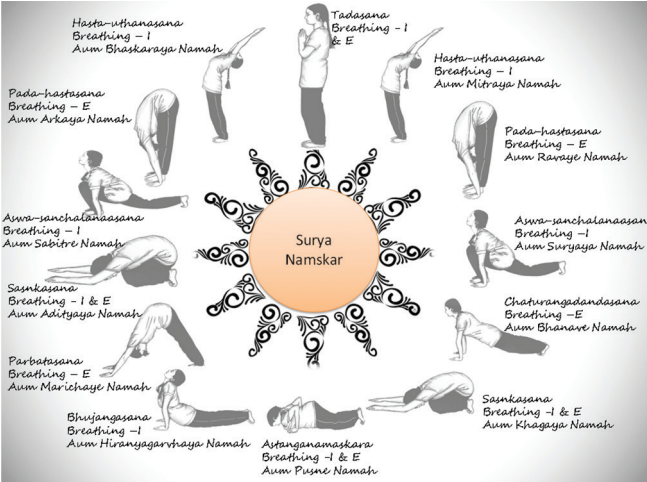








Figure 1: Potential beneficial effects of Yoga against COVID-19 infection

Table 1: Yoga modules for management of coronavirus disease 2019 9 patients with mild symptoms




Serial number	Category	Name of the yoga practice			
		Children 6-18 years	Adults, 18-60 years	Elderly > 60 years	
	Prayer	Vinayaka Remover of all obstacles	Maha Mrityunjaya Remover of fear of death	Dhanvantari Lord of health	
1	Loosening Exercises (Shithilikarana Vyayama)	Forward and backward bending(1 min) Spinal twisting (1 min) Mukha Dhouti (1/2 min) Surya Namaskar (2 rounds - 2 min)	Spinal twisting (1 minute) Forward and backward bending (1 min)	Forward and backward bending (1 min) Spinal twisting (1 min)	Spinal twisting on chair (1 min)
2	Breathing exercises and asana	Hands stretch breathing (1 min) Tiger breathing (1 min)	Hands in and out breathing (1 min) Hands stretch breathing (1 min each variation) Matsyasana/Sulabha Matsyasana (1 min)	Hands in and out breathing (1 min) Hands stretch breathing (1 min each variation) Chair Vakrasana (1 min) Sulabha Matsyasana (1 min)	Hands in and out breathing (1 min) Hands stretch breathing (1 min)
3	Kriya (cleansing techniques) and pranayama	Kapalabhati Kriya (30 strokes - 1 min) Nadishuddhi Pranayama (2 min)	Kapalabhati Kriya (30 strokes - 1 min) Abdominal breathing (1 min) Nadishuddhi Pranayama (2 min)	Kapalabhati Kriya (30 strokes - 1 min) Abdominal breathing (1 min) Surya Anuloma Viloma Pranayama (1 min) Nadishuddhi Pranayama (2 min)	Kapalabhati Kriya (15 strokes - 1 min) Nadishuddhi Pranayama (2 min)
4	Meditation	Sun meditation (2 min)	Sun meditation (2 min)	Sun meditation (2 min)	Sun meditation (2 min)
	Total duration of the video with intro etc.	18 min 24 s (practice time: 11 ½ min)	20 min 16 s (practice time: 11 min)	Module 1: 26 min 52 s (practice time: 12 ½ min)	Module 2: 16 min 23 s (practice time: 8 min)

Table 2: Script of the prayers and figures of the yoga practices

Vinayaka mantra	Mahamrityunjaya mantra	Dhanvantari mantra
OM HAM SAM bhagavate Nityayoga yuktaya Sacchidananda murtaye Vihayakaaya namah (I offer my salutation to lord Vinayaka who is established in yoga state and is the manifestation of the universal existence, consciousness, and bliss through these syllables OM, HAM, and SAM)	Trayambakam yajamahe Sugandhim pushtivardhanam Urvarukamiva Bandhnaat Mrityormuksheeyamamritaat Om shaantih Shaantih shantih (I offer my salutation to the three-eyed lord who is full of fragrance and gives energy and strength Drop off the fear of death just like a ripe cucumber drops from its stalk)	Om namami dhanvantarim aadi devam Suraasurairvandita paadapadmam Loke jara rugbhaya mrityunaasham Dataarameesham vividhoushadheenaam Om shaantih Shaantih shantih (I offer my salutation to the lotus feet of that original lord Dhanvantari who has given many medicines to remove fear of diseases and overcome aging and death to the world and saluted by all other gods)
Loosening practices Forward and backward bending	Spinal twist	Spinal twist on chair
		
Surya Namaskar		
Breathing practices Hands in and out breathing	Hands stretch breathing	Tiger breathing
		
Mukhadhouti	Matsyasana	Sulabha Matsyasana
		

Contd...

Table 2: Contd...

Vinayaka mantra	Mahamrityunjaya mantra	Dhanvantari mantra
Kapalabhati	Nadishuddhi Pranayama	Meditation
		

distress. We have previously taught an eight-stepped yoga breathing procedure consisting of very simple neck muscle relaxation movements and asanas with breathing exercises using the support of a chair during 110 episodes of acute airway obstruction in 86 bronchial asthma patients. There was a significant improvement in their PEFR by >20% within 30 min of the practice with successful relief from the episode. The patients reported reduction in panic and anxiety element, cutting the vicious cycle of aggravating bronchial obstruction. Based on the above discussed several beneficial aspects of yoga on the immune and respiratory systems against varied clinical settings including that of infectious diseases, we postulate a therapeutic potential of yoga towards COVID-19 prevention and management [Figure 1]. We have evolved age-specific sets of yoga modules [Tables 1 and 2] based on our extensive experience of over past 35 years on clinical research on yoga. The modules have been made available for public use on our website <https://svyasa.edu.in>. To this end, a pilot study was conducted on request providing a 4-min video of very simple practices as a voluntary clinical aid to the hospitalized COVID-19 patients in Milano, Italy, visited by 1000 people between March 17 and 20, 2020. The report by a cardiac surgeon who was also admitted in the intensive care unit of the Italy based hospital due to severe COVID-19 infection stated “We have reached scientific evidence that this simplified protocol sent by you is effective and we intend to disseminate to the overall Scientific Community”.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

- World Health Organization. Coronavirus Disease (COVID-19) Outbreak. World Health Organization; 2020. Available from: <https://www.who.int/emergencies/diseases/novel-coronavirus-2019>. [Last accessed on 2020 Feb 12].
- Raoult D, Zumla A, Locatelli F, Ippolito G, Kroemer G. Coronavirus infections: Epidemiological, clinical and immunological features and hypotheses. *Cell Stress* 2020. [Doi: 10.15698/cst2020.04.216].
- Wang D, Hu B, Hu C, Zhu F, Liu X, Zhang J, et al. Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus-infected pneumonia in Wuhan, China. *JAMA* 2020;7:e201585.
- Bedford J, Enria D, Giesecke J, Heymann DL, Ihekweazu C, Kobinger G, et al. COVID-19: Towards controlling of a pandemic. *Lancet* 2020;395:1015-8.
- Baud D, Qi X, Nielsen-Saines K, Musso D, Pomar L, Favre G. Real estimates of mortality following COVID-19 infection. *Lancet Infect Dis* 2020;S1473-3099(20)30195-X.
- Adhikari SP, Meng S, Wu YJ, Mao YP, Ye RX, Wang QZ, et al. Epidemiology, causes, clinical manifestation and diagnosis, prevention and control of coronavirus disease (COVID-19) during the early outbreak period: A scoping review. *Infect Dis Poverty* 2020;9:29.
- Zhu N, Zhang D, Wang W, Li X, Yang B, Song J, et al. A Novel coronavirus from patients with pneumonia in China, 2019. *N Engl J Med* 2020;382:727-33.
- Cascella M, Rajnik M, Cuomo A, Dulebohn S, Napoli R. Features, evaluation and treatment coronavirus (COVID-19). In: *StatPearls*. Treasure Island (FL): StatPearls Publishing; 2020. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK554776/>. [Last updated on 2020 Mar 08].
- Guo YR, Cao QD, Hong ZS, Tan YY, Chen SD, Jin HJ, et al. The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak-An update on the status. *Mil Med Res* 2020;7:11.
- Chan JF, Yuan S, Kok KH, To KK, Chu H, Yang J, et al. A familial cluster of pneumonia associated with the 2019 novel coronavirus indicating person-to-person transmission: A study of a family cluster. *Lancet* 2020;395:514-23.
- Weiss SR, Leibowitz JL. Coronavirus pathogenesis. *Adv Virus Res* 2011;81:85-164.
- Cui J, Li F, Shi ZL. Origin and evolution of pathogenic coronaviruses. *Nat Rev Microbiol* 2019;17:181-92.
- Matthews CE, Ockene IS, Freedson PS, Rosal MC, Merriam PA, Hebert JR. Moderate to vigorous physical activity and risk of upper-respiratory tract infection. *Med Sci Sports Exerc* 2002;34:1242-8.
- Fauci AS, Lane HC, Redfield RR. Covid-19-Navigating the uncharted. *N Engl J Med* 2020;382:1268-9.
- World Health Organization. Coronavirus Disease (COVID-2019) Situation Reports. Situation Report-55. Available from: https://www.who.int/docs/default-source/coronavirus/situation-reports/20200315-sitrep-55-covid-19.pdf?sfvrsn=33daa5cb_6. [Last accessed on 2020 Mar 15].
- Parodi SM, Liu VX. From containment to mitigation of COVID-19 in the US. 2020. Epub ahead of print.

17. Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, *et al.* Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* 2020;395:497-506.
18. Fang L, Karakiulakis G, Roth M. Are patients with hypertension and diabetes mellitus at increased risk for COVID-19 infection? *Lancet Respir Med* 2020;8:e21.
19. Zhang J, Zhou L, Yang Y, Peng W, Wang W, Chen X. Therapeutic and triage strategies for 2019 novel coronavirus disease in fever clinics. *Lancet Respir Med* 2020;8:e11-2.
20. The Lancet Respiratory Medicine. COVID-19: Delay, mitigate, and communicate. *Lancet Respir Med* 2020;8:321.
21. Anderson RM, Heesterbeek H, Klinkenberg D, Hollingsworth TD. How will country-based mitigation measures influence the course of the COVID-19 epidemic? *Lancet* 2020;395:931-4.
22. Colson P, Rolain JM, Lagier JC, Brouqui P, Raoult D. Chloroquine and hydroxychloroquine as available weapons to fight COVID-19. *Int J Antimicrob Agents* 2020:105932. doi: 10.1016/j.ijantimicag.2020.105932. Epub ahead of print.
23. Chen Z, Hu J, Zhang Z, Jiang SS, Han S, Yan D, *et al.* Efficacy of hydroxychloroquine in patients with COVID-19: Results of a randomized clinical trial. medRxiv 2020.03.22.20040758; doi: <https://doi.org/10.1101/2020.03.22.20040758>.
24. Mitjà O, Clotet B. Use of antiviral drugs to reduce COVID-19 transmission. *Lancet Glob Health* 2020. doi: 10.1016/S2214-109X(20)30114-5. Epub ahead of print.
25. Gard T, Noggle JJ, Park CL, Vago DR, Wilson A. Potential self-regulatory mechanisms of yoga for psychological health. *Front Hum Neurosci* 2014;8:770.
26. Telles S, Naveen KV, Dash M. Yoga reduces symptoms of distress in tsunami survivors in the Andaman Islands. *Evid Based Complement Alternat Med* 2007;4:503-9.
27. Cramer H, Lauche R, Anheyer D, Pilkington K, de Manincor M, Dobos G, *et al.* Yoga for anxiety: A systematic review and meta-analysis of randomized controlled trials. *Depress Anxiety* 2018;35:830-43.
28. Telles S, Singh N, Joshi M. Risk of posttraumatic stress disorder and depression in survivors of the floods in Bihar, India. *Indian J Med Sci* 2009;63:330-4.
29. Nagarathna R, Nagendra HR. Yoga for bronchial asthma: A controlled study. *Br Med J (Clin Res Ed)* 1985;291:1077-9.
30. Cramer H, Posadzki P, Dobos G, Langhorst J. Yoga for asthma: A systematic review and meta-analysis. *Ann Allergy Asthma Immunol* 2014;112:503-10.
31. Nivethitha L, Mooventhan A, Manjunath NK. Effects of various prāṇāyāma on cardiovascular and autonomic variables. *Anc Sci Life* 2016;36:72-7.
32. Hagins M, States R, Selfe T, Innes K. Effectiveness of yoga for hypertension: Systematic review and meta-analysis. *Evid Based Complement Alternat Med* 2013;2013:649836.
33. Pullen PR, Seffens WS, Thompson WR. Yoga for Heart Failure: A Review and Future Research. *Int J Yoga* 2018;11:91-8.
34. Nagarathna R, Ram CV, Rajesh SK, Singh A, Majumdar V, Patil S, *et al.* Nagendra diabetes prevention through yoga-based lifestyle: A pan-India randomized controlled trial. *Diabetes* 2019;68 Suppl 1:129.
35. Raveendran AV, Deshpandae A, Joshi SR. Therapeutic role of yoga in type 2 diabetes. *Endocrinol Metab (Seoul)* 2018;33:307-17.
36. Innes KE, Selfe TK. Yoga for adults with type 2 diabetes: A systematic review of controlled trials. *J Diabetes Res* 2016;2016:6979370.
37. McDermott KA, Rao MR, Nagarathna R, Murphy EJ, Burke A, Nagendra RH, *et al.* A yoga intervention for type 2 diabetes risk reduction: A pilot randomized controlled trial. *BMC Complement Altern Med* 2014;14:212.
38. Singh AK, Kaur N, Kaushal S, Tyagi R, Mathur D, Sivapuram MS, *et al.* Partitioning of radiological, stress and biochemical changes in pre-diabetic women subjected to Diabetic Yoga Protocol. *Diabetes Metab Syndr* 2019;13:2705-13.
39. Obasi CN, Brown R, Ewers T, Barlow S, Gassman M, Zgierska A, *et al.* Advantage of meditation over exercise in reducing cold and flu illness is related to improved function and quality of life. *Influenza Other Respir Viruses* 2013;7:938-44.
40. Barrett B, Hayney MS, Muller D, Raket D, Ward A, Obasi CN, *et al.* Meditation or exercise for preventing acute respiratory infection: A randomized controlled trial. *Ann Fam Med* 2012;10:337-46.
41. Visweswaraiiah NK, Telles S. Randomized trial of yoga as a complementary therapy for pulmonary tuberculosis. *Respirology* 2004;9:96-101.
42. Naoroibam R, Metri KG, Bhargav H, Nagaratna R, Nagendra HR. Effect of Integrated Yoga (IY) on psychological states and CD4 counts of HIV-1 infected patients: A randomized controlled pilot study. *Int J Yoga* 2016;9:57-61.
43. Dunne EM, Balletto BL, Donahue ML, Feulner MM, DeCosta J, Cruess DG, *et al.* The benefits of yoga for people living with HIV/AIDS: A systematic review and meta-analysis. *Complement Ther Clin Pract* 2019;34:157-64.
44. Hari Chandra BP, Ramesh MN, Nagendra HR. Effect of Yoga on Immune Parameters, Cognitive Functions, and Quality of Life among HIV-Positive Children/Adolescents: A Pilot Study. *Int J Yoga* 2019;12:132-8.
45. Marsland AL, Bachen EA, Cohen S, Rabin B, Manuck SB. Stress, immune reactivity and susceptibility to infectious disease. *Physiol Behav* 2002;77:711-6.
46. Falkenberg RI, Eising C, Peters ML. Yoga and immune system functioning: A systematic review of randomized controlled trials. *J Behav Med* 2018;41:467-82.
47. Morgan N, Irwin MR, Chung M, Wang C. The effects of mind-body therapies on the immune system: Meta-analysis. *PLoS One* 2014;9:e100903.
48. Xiang YT, Yang Y, Li W, Zhang L, Zhang Q, Cheung T, *et al.* Timely mental health care for the 2019 novel coronavirus outbreak is urgently needed. *Lancet Psychiatry* 2020;7:228-9.
49. Lim SA, Cheong KJ. Regular yoga practice improves antioxidant status, immune function, and stress hormone releases in young healthy people: A randomized, double-blind, controlled pilot study. *J Altern Complement Med* 2015;21:530-8.
50. Gopal A, Mondal S, Gandhi A, Arora S, Bhattacharjee J. Effect of integrated yoga practices on immune responses in examination stress-A preliminary study. *Int J Yoga* 2011;4:26-32.
51. Shi Y, Wang Y, Shao C, Huang J, Gan J, Huang X, *et al.* COVID-19 infection: The perspectives on immune responses. *Cell Death Differ* 2020. doi: 10.1038/s41418-020-0530-3. Epub ahead of print.
52. Infante JR, Peran F, Rayo JI, Serrano J, Dominguez ML, Garcia L, *et al.* Levels of immune cells in transcendental meditation practitioners. *Int J Yoga* 2014;7:147-51.
53. Kamei T, Toriumi Y, Kimura H, Kimura K. Correlation between alpha rhythms and natural killer cell activity during yogic respiratory exercise. *Stress Health* 2001;17:141-5.
54. Tooley GA, Armstrong SM, Norman TR, Sali A. Acute increases in night-time plasma melatonin levels following a period of meditation. *Biol Psychol* 2000;53:69-78.
55. Witek-Janussek L, Albuquerque K, Chroniak KR, Chroniak C, Durazo-Arvizu R, Mathews HL. Effect of mindfulness based

- stress reduction on immune function, quality of life and coping in women newly diagnosed with early stage breast cancer. *Brain Behav Immun* 2008;22:969-81.
56. Chen PJ, Yang L, Chou CC, Li CC, Chang YC, Liaw JJ. Effects of prenatal yoga on women's stress and immune function across pregnancy: A randomized controlled trial. *Complement Ther Med* 2017;31:109-17.
 57. Pedersen SF, Ho YC. SARS-CoV-2: A storm is raging. *J Clin Invest*. 2020. pii: 137647.
 58. Casqueiro J, Casqueiro J, Alves C. Infections in patients with diabetes mellitus: A review of pathogenesis. *Indian J Endocrinol Metab* 2012;16 Suppl 1:S27-36.
 59. Yang X, Yu Y, Xu J, Shu H, Xia J, Liu H, *et al.* Clinical course and outcomes of critically ill patients with SARS-CoV-2 pneumonia in Wuhan, China: A single-centered, retrospective, observational study. *Lancet Respir Med* 2020;8:e26.
 60. Guan WJ, Ni ZY, Hu Y, Liang WH, Ou CQ, He JX, Liu L, *et al.* China medical treatment expert group for covid-19. Clinical characteristics of coronavirus disease 2019 in China. *N Engl J Med* 2020;NEJMoa2002032. Epub ahead of print.
 61. Fang L, Karakiulakis G, Roth M. Antihypertensive drugs and risk of COVID-19? – Authors' reply. *Lancet Respir Med* 2020;S2213-2600(20)30159-4.
 62. Li G, Hu R, Zhang X. Antihypertensive treatment with ACEI/ARB of patients with COVID-19 complicated by hypertension. *Hypertens Res* 2020;1-3.
 63. Gralinski LE, Menachery VD. Return of the Coronavirus: 2019-nCoV. *Viruses* 2020;12:135.
 64. Nivethitha L, Mooventhan A, Manjunath NK. Effects of various prāṇāyāma on cardiovascular and autonomic variables. *Anc Sci Life* 2016;36s: 72-7.
 65. Cernes R, Zimlichman R. RESPerATE: The role of paced breathing in hypertension treatment. *J Am Soc Hypertens* 2015;9:38-47.
 66. Saoji AA, Raghavendra BR, Manjunath NK. Effects of yogic breath regulation: A narrative review of scientific evidence. *J Ayurveda Integr Med* 2019;10:50-8.
 67. Santaella DF, Devesa CR, Rojo MR, Amato MB, Drager LF, Casali KR, *et al.* Yoga respiratory training improves respiratory function and cardiac sympathovagal balance in elderly subjects: A randomised controlled trial. *BMJ Open* 2011;1:e000085.
 68. Madan M, Thombre DP, Balakumar B, Nambinarayanan TK, Thakur S, Krishnamurthy N, *et al.* Effect of yoga training on reaction time, respiratory endurance and muscle strength. *Indian J Physiol Pharmacol* 1992;36:229-33.
 69. Joshi LN, Joshi VD, Gokhale LV. Effect of short term 'Pranayam' practice on breathing rate and ventilatory functions of lung. *Indian J Physiol Pharmacol* 1992;36:105-8.
 70. Karthik PS, Chandrasekhar M, Ambareesha K, Nikhil C. Effect of pranayama and suryanamaskar on pulmonary functions in medical students. *J Clin Diagn Res* 2014;8:BC04-6.
 71. Hakked CS, Balakrishnan R, Krishnamurthy MN. Yogic breathing practices improve lung functions of competitive young swimmers. *J Ayurveda Integr Med* 2017;8:99-104.
 72. Liu XC, Pan L, Hu Q, Dong WP, Yan JH, Dong L. Effects of yoga training in patients with chronic obstructive pulmonary disease: A systematic review and meta-analysis. *J Thorac Dis* 2014;6:795-802.
 73. Gupta A, Gupta R, Sood S, Arkham M. Pranayam for treatment of chronic obstructive pulmonary disease: Results from a randomized, controlled trial. *Integr Med (Encinitas)* 2014;13:26-31.
 74. Donesky-Cuenca D, Nguyen HQ, Paul S, Carrieri-Kohlman V. Yoga therapy decreases dyspnea-related distress and improves functional performance in people with chronic obstructive pulmonary disease: A pilot study. *J Altern Complement Med* 2009;15:225-34.
 75. Ranjita R, Hankey A, Nagendra HR, Mohanty S. Yoga-based pulmonary rehabilitation for the management of dyspnea in coal miners with chronic obstructive pulmonary disease: A randomized controlled trial. *J Ayurveda Integr Med* 2016;7:158-66.
 76. Fulambarker A, Farooki B, Kheir F, Copur AS, Srinivasan L, Schultz S. Effect of yoga in chronic obstructive pulmonary disease. *Am J Ther* 2012;19:96-100.
 77. Pomidori L, Campigotto F, Amatya TM, Bernardi L, Cogo A. Efficacy and tolerability of yoga breathing in patients with chronic obstructive pulmonary disease: A pilot study. *J Cardiopulm Rehabil Prev* 2009;29:133-7.
 78. de Boer PT, van Maanen BM, Damm O, Ultsch B, Dolk FC, Crepey P, *et al.* A systematic review of the health economic consequences of quadrivalent influenza vaccination. *Expert Rev Pharmacoecon Outcomes Res* 2017;17:249-65.
 79. Arinaminpathy N, Kim IK, Gargiullo P, Haber M, Foppa IM, Gambhir M, *et al.* Estimating direct and indirect protective effect of influenza vaccination in the United States. *Am J Epidemiol* 2017;1-9. 3089949.
 80. Bridges CB, Thompson WW, Meltzer MI, Reeve GR, Talamonti WJ, Cox NJ, *et al.* Effectiveness and cost-benefit of influenza vaccination of healthy working adults: A randomized controlled trial. *JAMA* 2000;284:1655-63.
 81. Gatwood J, Meltzer MI, Messonnier M, Ortega-Sanchez IR, Balkrishnan R, Prosser LA. Seasonal influenza vaccination of healthy working-age adults: A review of economic evaluations. *Drugs* 2012;72:35-48.
 82. Postma MJ, Baltussen RM, Heijnen ML, de Berg LT, Jager JC. Pharmacoeconomics of influenza vaccination in the elderly: Reviewing the available evidence. *Drugs Aging* 2000;17:217-27.
 83. Bhanushali D, Tyagi R, Limaye Rishi Nityapragya N, Anand A. Effect of mindfulness meditation protocol in subjects with various psychometric characteristics at high altitude. *Brain Behav* 2020:e01604. [Doi: 10.1002/brb3.1604].