

A review on exploring evidence-based approach to harnessing the immune system in times of corona virus pandemic: Best of modern and traditional Indian system of medicine

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ABSTRACT

Coronavirus (COVID-19) is the most dreaded pandemic of our times, which lead to a state of chaos among the mightiest nations of the world. The immune system plays a great role in response to any foreign organisms be it bacteria or viruses. Virus-based pandemics like SARS, MERS, COVID-19 have time and again been surfacing leading to mortality and morbidity worldwide. These pandemics have also resurfaced the role of public health and its modes which have been fading in the presence of lucrative hi-tech medical industry. Although Chinese system of medicine has been explored, there is still more to be done in exploring solutions from time tested Indian systems of medicine like Ayurved and Yog. Its time to rethink and explore ways to harness our immune system and look for evidence-based solutions providing the best of both medical systems to the patients, i.e., modern medicine as well as Ayurved and Yog. The present review is a narrative review wherein studies were searched from databases like PubMed, Cochrane, Scopus, and web pages. Given a paucity of studies hereby we explored existing pieces of evidence, thereby concluding that more randomized controlled trials need to be done for assessing the role of Ayurved, Yog, and other Indian systems of medicine to enrich the armamentarium in the fight against such viruses in future. Family physicians can play a vital role in not only suggesting treatment but also changes in lifestyle of the patients as well as their family. Evidence based knowledge of ancient Indian system will open a new door of integration for overall well being of patient with a scientific outlook.

Keywords: COVID-19, immune system, immunity, pandemic, sars-cov-2, wuhanvirus

Introduction

The World Health Organization has declared the Coronavirus (COVID-19) outbreak as a pandemic. This is a

disease that hopped from animals to humans just like SARS and MERS. Several things are unclear regarding COVID-19 and much remains unknown. The only way left for all of us is prevention. Although medical experts and scientists are working religiously for a cure, there is no confirmed vaccine available yet and treatment till date remains supportive.^[1] What needs to be done is to not panic, use the best methods of prevention and boost our immunity. In a war, whenever there is a foreign threat

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against the state, the first thing that is strengthened is the defense mechanism. Considering COVID-19 as an invader toward our body, we need to strengthen our innate defense mechanisms. In this scenario, we need to consider and scientifically accept the best from all medical systems without prejudice for the wellbeing of all. Ancient Indian system of medicine is time tested and needs to be explored. We have enough evidence in modern medicine on modes of boosting our immune system.

Dyadic of Coronavirus and Immunity

COVID-19 are enveloped non-segmented positive-sense single-stranded RNA viruses with the largest viral RNA genome.^[2] Although new data are surfacing every day as the human population around the globe is going through various phases of this disease, yet we hereby tried to explore for solutions as the disease started showing its presence in the Indian subcontinent.

In a recent case study from Australia, various concomitant immune responses were studied in a previously healthy, non-smoker 47-year-old woman not on any medications, showing symptoms of moderate COVID-19.^[3] Throughout her recovery, an increase was seen in antibody-secreting cells, follicular helper T-cells, activated CD4+ and CD8+ T-cells, and immunoglobulin M and G antibodies, indicating that the immune response to COVID-19 was similar to that of Influenza. Their findings suggest that in an otherwise healthy person, this novel virus is dealt robustly by the immune system and suggest that an early adaptive immune response might be responsible for good clinical outcomes.^[3]

However, on the contrary, a study on 41 hospitalized severe COVID-19 cases showed high levels of pro-inflammatory cytokines. An increased number of neutrophils and a decreased number of lymphocytes were also seen in these cases.^[4] Another report investigating 99 cases from Wuhan showed similar findings to an increase in total neutrophils by 38%, serum interleukin-6 (IL)-6 by 52%, and increased C-reactive protein by 84% along with a decrease in total lymphocytes by 35%.^[5]

A direct correlation could be seen between disease severity/disease-related mortality and an increase in neutrophil counts/decrease in lymphocyte counts in COVID-19 cases.^[6] Along with this, the rise in levels of pro-inflammatory cytokines following COVID-19 infection is something that was also seen in SARS-CoV and MERS Co-V infections and might be an important and significant factor contributing to disease pathogenesis.^[7-9]

Different case studies on severe COVID-19 patients of China and earlier studies on SARS and MERS infections, all point to control cytokine production and inflammatory response, to prohibit accumulation of cells and fluids in the lungs and safeguard COVID-19 pneumonia cases. It is also suggested to keep the production of different inflammatory markers

under check while reducing oxygen radicals and Neutrophil extracellular traps (NETs) formation.^[2] Theory of cytokine storm and significant role of inflammation as suggested by recent studies by Felsenstein *et al.*, lays a platform for development of immunomodulatory treatments in near future.^[10]

Immune Strengthening as per Modern Medicine

To function optimally, the human body requires energy in the form of glucose, amino acids, and fatty acids. Along with these fuel sources, micronutrients like vitamins and minerals are needed to recover from exertion (both physically and mentally), to heal, replace and replenish the worn-out cells and tissues of the body, and to maintain homeostasis. Similarly, the immune system is equally dependent upon these macro- and micronutrients. The immune system's ability to rid the body of pathogens (aka resistance) depends upon the adequate supply of nutrients. At times, immune function can also be influenced by severe energy restrictions, which in turn activates the HPA axis and releases stress hormones to flush out pathogens from the system.^[11] However, this may be very taxing on the body and is generally followed by a long and crucial recovery period.

The immune system plays a dual role, acting as a resistant by protecting the body from the pathogens by fighting against them, and acting as a tolerant by enduring the microbes present within the body.^[12] An equilibrium between these two sides of immunity is needed. A hyper-vigilant immune response may sap the vital organs of energy and cause unwanted tissue damage, on the contrary, a feeble immune response may not be able to fight the pathogens efficiently enough, giving way to disease occurrence.^[13]

As per the article published from Harvard medical school, they have outlined few ways of boosting one's immune mechanism like healthy lifestyle, adequate sleep, adequate immunizations, not smoking, diet rich in fruits and vegetables, restricted saturated fats and sugars, minimal consumption if any of red and processed meat, regular exercise around 150 min per week, maintaining healthy body weight, and blood pressure.^[14]

5 Key Factors Strengthening Immunity

- **Nutrition:** There is strong evidence available in favour of micronutrients like vitamin C, D, and zinc in strengthening immune health of an individual.^[15] Micronutrients like iron, zinc, magnesium, Vitamin C, D etc., are essential for nucleotide and nucleic acid synthesis and also limit tissue damage and are of utmost importance for the proper functioning of the immune response. The readily available supply of micronutrients plays a crucial role in host defence, as they partake in antioxidant defences to tackle increased oxidative stress during an immune response.^[16] Their deficiency may cause collateral tissue damage, which explains the increased demand for anti-oxidants during sickness. Some micronutrients like Vitamin D straight away

regulate gene expressions and influence the immune system in a direct manner.^[17,18] Vitamin C is found abundantly in leucocytes; however, their number decreases drastically as they help diminish excessive tissue damage during cold and flu.^[13,19] When oxidative stress increases during sickness, Vitamin C acts as an antioxidant, hunting upon reactive oxygen species, ridding them from cellular fluids within and without. Studies suggest that daily doses of Vitamin C (>200 mg) may have therapeutic and preventive effects for common cold.^[20,21] Apart from its function on calcium absorption and bone health, Vitamin D is a major player when it comes to immune functioning. Many of the immune cells, including antigen-presenting cells like T cells and B cells, are equipped with receptors which can synthesize the biologically active form of Vitamin D. It has an anti-inflammatory effect in the responses of the acquired immune system; however, it enhances the innate immune system by inducing antimicrobial proteins. Regular Vitamin D supplementation has been shown to have protective effects against respiratory infections in those having its deficiency at the baseline.^[22] Apart from dietary supplementation in regions where sunlight is unavailable during winters, Vitamin D deficiency can be overcome by regular and safe sunlight exposure of skin, as it provides for almost 80 to 100% of the body's requirements. Also, minerals like zinc have been shown to induce therapeutic benefits for upper respiratory tract infection (URI) and reduce its duration by almost 3 days when taken within a day of symptom onset and continued until signs of recovery.^[23] This can be attributed to the inhibitory effects of zinc on the viral activity, as it increases interferon-gamma and decreases docking of viruses at the binding sites of the oropharyngeal region by decreasing the levels of intracellular adhesion molecule-1.^[24,25] Zinc also has favorable effects on the tolerance part of immunity due to its antioxidant and anti-inflammatory properties.^[26] Hence, it is important to consume all seasonal locally available fruits and vegetables especially citrus fruits and green leafy vegetables to equip our immune systems with the right arms to fight off the invading pathogens. Regular consumption of pre and probiotics modulates the gut microbiota.^[27,28] Probiotics benefit immunity and infection resistance especially in the case of respiratory and gastrointestinal infections.^[29] They do so by competing with the pathogens for nutrition and hinder them from attaching to intestinal epithelial walls. Some of their by-products released in the guts, like lactic acid, act as an inhibitor for pathogen growth.^[30] Probiotic supplementation has been shown to reduce the incidence of acute upper respiratory infections by approximately 50% along with a shortened duration of disease and reduction in antibiotic prescriptions.^[16,31] Probiotics not only help build resistance, but also improve tolerance, by acting upon the common mucosal immune system and preventing inflammatory responses to occur in the guts, when not needed, like for a harmless foreign particle, and thus help maintain immunological homeostasis.^[28,29] The traditional Indian cuisines have a variety of probiotic foods and drinks

like Dahi/chaach (curd/buttermilk), achar (pickles), idli and dosa (south Indian delicacies), dhokla (Gujarati delicacy), kaanji (a fermented drink common to north India, made from black carrots and mustard seeds), and many more.^[32]

- **Healthy and Active Lifestyle:** Evidence suggests that immunity is enhanced by regular and frequent bouts of exercise, implying that an active lifestyle reduces the incidence of not only communicable diseases but also non-communicable diseases too.^[33] Exercise improves blood circulation, allowing a better flow of white blood cells (WBCs), antigens and other immune organelles, helping better detection of pathogens. Exercise also helps reduce stress by slowing down the release of stress hormones.^[34] Bicycling few times in a week, walking for 20 to 30-min daily, working out at a gym on alternate days etc., are some easy options for boosting the immune system.
- **Quality of Sleep:** As the body needs rest to recover, so does the immune system. Chronic sleep deprivation can disturb the immune homeostasis and increase the risk of or impact of diseases involving immune dysregulation. Moreover, adequate and good quality sleep is associated with a reduced risk of infectious diseases and can help improve infection outcomes.^[35]
- **Avoiding smoking and alcohol consumption:** Smoke, from cigarettes, in particular, regulate NFkB and MAPK signalling along with histone modification, thus interrupting immunological homeostasis. Moreover, it acts as a double-edged sword by weakening immune function and promoting autoimmunity.^[36] Apart from smoking, alcohol acts as an immunomodulator by reducing the effect of inflammatory cell function to pathogen-derived signals.^[37] Moreover, antigen-specific T-cell proliferation gets downregulated as alcohol exposure inhibits and impairs the antigen-presenting function of monocytes, macrophages, and other innate immune cells.^[37] NK cell functions are also hindered by alcohol consumption, giving way to alcohol-induced immune defects.^[37] It also affects T-cells function, which in turn influences the function of memory T-cells. Such modulations in the immune system organelles caused due to alcohol consumption hinder the adaptive immune response. Therefore, an increased incidence of pneumonia along with the poor outcome of infections is seen in people having drinking problems.^[37]
- **Personal and Environmental Hygiene:** Good hygiene practices like washing hands before having meals and after using urinal/latrine, taking a bath every day, maintaining the clean and hygienic environment around living spaces, washing and cooking foods before eating can prevent infectious diseases to some extent.

Stress and Its Effects on the Immune System

Time-bound acute stress makes the innate immune system react to the perceived dangers differently, like by preparing to fight against some viral/bacterial invaders or to heal some wound etc., by redistributing immune cells throughout the body.

As most governments around the globe have put rigorous measures to restrict the spread of the deadly COVID-19, overindulgence in social media is on the rise which acts as a stress inducer and compromises immunity. A study conducted on undergraduate college students revealed that there was a direct positive correlation between the size of social network groups (e.g., number of friends on Facebook) and incidence rate of URIs.^[38] Stress and anxiety during this pandemic gets added up by the spread of fake news and misinformation. Hence, it is important to use only authentic information being shared on government websites. It is good to limit the use of social media and attend to the family and closed ones. Other than that, one can utilize this time to improve one's talents and personal skills and indulge in more proactive and creative activities while staying at home only, as it would make one happier and joyous, helping reduce stress thereby boosting the immune system. In a recent tweet, H.H. Sri Sri Ravi Shankar said "Social distancing is not a punishment. Silence and solitude are potent means for personal growth and self-renewal".^[39] In this time of the pandemic, WHO is promoting social distancing, so here we have to reconsider the ancient practice of getting close to oneself.

Ayurveda and Immune Strengthening

Acharya Charaka, one of the great proponents of Ayurveda, described in Charaka Samhita's Chapter 3 of Vimana Sthana, that different individuals have different bodily constitution and immunity; however, there may be common factors like air, water etc., which when vitiated, may lead to various diseases of a particular place, termed as "Janapadhodhwamsa." "Janapada" refers to an area which is inhabited by living beings^[40] and "Dhwamsa" refers to destruction, hence anything that leads to the destruction of a particular habitat due to Sankramika-Roga (Communicable diseases) is a Janapadhodhwamsa. (CH.VI.1/1) Acharya Sushruta in Sushruta Samhita also gives an overview of the Sankramika Vyadhis/Aupasargika Vyadhis (communicable diseases) while classifying diseases which spread by contact with the affected person, or by inhaling the same air as the person who is affected with the disease, or by using of same clothes leading to spread of various diseases (SU.NI.5/35).

The term Vyadhi Kshamatwa (Vyadhi stands for disease and Kshamatwa means potency or ability) is defined as the ability of the body to prevent or resist the development of the disease. The Vyadhi Kshamatwa is basically of two types 1) Vyadhi Pratibandhakatwa, one that prevents the onset of disease 2) Vyadhi Balanirodhakatwa, one that withstands the virility of the disease. Hence, for the treatment of Janapadodhwamsa, Acharya Charaka advocates the use of Rasayana which helps in replenishing the Dhatus (tissues) and thereby helps in increasing the Vyadhi Kshamatwa.

Acharya Sushruta gives further classifications of Rasayana namely 1) Kamyasayana: which is taken to increase the longevity and intelligence of the person, 2) Naimaitika Rasayana: which is taken during the disease, acting as an adjuvant, and 3) Ajsrika Rasayana: which can be taken on the daily bases, milk for example.

The various drugs which are considered to be Rasayana according to ayurvedic texts include Guduchi/Amrita (*Tinospora Cordifolia*) (as per Sharangdhara Samhita), Amalaki (*Phyllanthus Emblica*), and Maricha (*Piper Nigrum*). Studies suggest that administration of these plant-based adaptogens via oral or intravenous route may help re-establish immune competency in conditions like cancer/tumour and in other severe conditions which compromise the immune system because of their immuno-stimulating properties which help survey and regulate the activity of NK Cells, lymphocytes (T & B), immunoglobulins, tumour necrosis factor alpha (TNF- α), macrophages, polymorphonuclear cells, and interleukins.^[41-45]

- **Guduchi (*Tenospora Cordifolia*):** Guduchi acts as an antioxidant and a known immunomodulator. The fresh juices of Guduchi and Brahmi have known to be helping in enhancing the immunity of the individual and also act as an antioxidant.^[46] Octacosanol isolated from the plant has been shown to act as an active anti-angiogenic and anti-metastatic.^[47]
- **Amalaki (*Embelia Officinale*):** Researches with crude extracts of *Amalaki* have proven the antioxidant and immunomodulatory activities. It is considered to be Balya (strength giver) in Ayurveda and is known to impart strength to the body. Amla and its products are a rich source of vitamin C.^[48] supplementation of vitamin C becomes important to prevent respiratory and other systemic infection.^[49] Its hydrochloric extract has been shown to act as an anti-inflammatory in albino rats showing an increase in glutathione, superoxide dismutase, and catalase activity along with a reduction in lipid peroxidation and malondialdehyde while inhibiting NF- κ B activation and quenching inducible nitric oxide synthase (iNOS).^[45,50]
- **Maricha (*Piper Nigrum*):** Maricha is known to increase the bioavailability of the drug that it is usually given with. It is a well-known Rasayana which is anti-oxidant in nature and also increases total WBC.^[51] It is also known to act as an anti-inflammatory agent as the active content, i.e., piperine is found to inhibit the expression of IL6 and MMP13 and helps in reduced PGE2 in a dose-dependent manner at concentration of 10–100 μ g/ml.^[90] (Bang JS, Choi HM, Sur BJ, Lim SJ, Kim JY, Yang HI, Yoo MC, Hahm DH, Kim KS. Anti-inflammatory and antiarthritic effects of piperine in human interleukin 1 β -stimulated fibroblast-like synoviocytes and in rat arthritis models. *Arthritis research & therapy*. 2009 Apr 1;11 (2):R49.)
- **Brahmi (*Bacopa Monnieri*):** Brahmi acts on the central nervous system and slows down the stress activity. In cases of global distress or epidemic, people usually get paranoid, so it might be helpful to reduce stress and anxiety. An in-vitro study suggests that bacoside-rich ethanolic extracts have anti-inflammatory effects by controlling the Th1-polarised immune responses while suppressing NO (and TNF- α) by macrophages and IFN by innate lymphocytes. It also showed a sustained production of IL-10, which is indicative of neutralizing Th1 activation and favouring regulatory

T cells activation.^[52] Stigmasterol of Brahmi as antitumor showed an increase in the levels of glutathione, superoxide dismutase, and catalase and a reduction in lipid peroxidation and membrane micro-viscosity.^[45,53]

- **Turmeric (Curcuma Longa):** It forms a very essential part of the Indian cooking. It is one of the most important spices of India and also considered as one of the rasayana. Curcumin is the main polyphenol separated from turmeric are known to possess an anti-oxidant, anti-inflammatory as it reduces TNF- α and IL-1, anti-metastatic activities.^[54] It also targets various inflammatory mediators like cyclooxygenase-2, inducible nitric oxide synthase, and nuclear factor κ B (NF- κ B), which further diminishes the release of proinflammatory and profibrotic cytokines, further suppressing the free radical production which ends further tissue toxicity.^[55] It is also identified as NLRP3 inflammation activation inhibitor.^[56] It is also known to have a cytotoxic effect and is also known to enhance immunity through T cell stimulation along with anti-metastatic effect which was seen in pre-clinical colorectal cancer models.^[57]
- **Tulasi (Ocimum Tenuiflorum):** Tulasi is known to be as “Elixir of life”. It is also given the equal importance of divinity according to the Indian civilization. It forms a part of every household. The use of tulasi leaves have been in use since the time immemorial in conditions like fever, any respiratory issues as a common practice. There have been different studies which also states the efficacy of Tulasi as an immunomodulator, anti-oxidant, anti-inflammatory, anti-pyretic, and also analgesic property.^[58] The studies have shown the increase in natural killer cell and also increase in the percentage of T-helper cells after 4 weeks of intervention on healthy volunteers in comparison to placebo group.^[59] The aqueous extract of tulasi has inhibitory effect on polio virus type 3, enterovirus, viral encephalitis, herpes virus.^[60] The bronchodilator activity of tulasi in mild to moderate asthmatic patients has also been reported in single blind over study for a period of 1 week leading to improved FEV1 (Forced Expiratory Volume) and PEFr (Peak Expiratory Flow Rate) values along with the improvement in the symptoms of asthma.^[10]
- **Hot water and Copperized Water:** Hot water helps in Ama Pachana (digestion of sludge resulting from undigested food) and establishing the Agni (Bio-Digestive Fire) and also improves digestion. When Agni is working optimally, it gives immunity; therefore, we should regularly drink hot water. Also, In Indian culture, usually drinking water is stored in a copper vessel. As per Ayurveda this is known as Tamra Jal (copper water) and is a process that cleanses and ionizes the water with the properties of copper. Water stored in copper vessels acts as a natural antioxidant and helps balance the three doshas of Vata (wind), Pitta (bile), and Kapha (phlegm). Research studies have shown that using a copper vessel for storing drinking water is far more effective than any plastic or stainless-steel vessel as it helps eliminate the residing bacteria in the water.^[61,62]

When we understand the concept of Rasayana from a modern lens it can be considered as a rejuvenating approach to deal with

a particular condition to increase the resistance of the body toward the disease.

Ayurveda states that disease has two manifestations, Manasika (psychosomatic) and Sharirika (bodily). Hence, the Rasayana concept further acts on both these aspects with drug therapy on the Shareera (body) and Achara Rasayana which can be equated to good conduct with charity that acts as psychological therapy.

The ancient way followed for sterilization was burning of Neem/Nimba (*Azadirachta indica*) leaves. For the success of surgery, various methods of sterilization were explained (for patients lived in Vranitagar, Sutikagar, Kumaragar, etc., for wound Vrana, for instruments [Yantra Shastra] etc) like Kashaya (medicinal Decoction), Parishekah (steam pouring), Agnitapan (applying heat with a brick or sand poultice) Dhoopana (Fumigation) with Rakshoghna dravya's, such as Guggulu (*Commiphora Wightii*), Aguru (*Aquilaria Agallocha*), Sarjarasa (Resina of Shorear Obusta Gaerten), Vacha (*Acorus Calamus*), Sarshap (*Brassica Nigra*), Lavana (Sodium Chloride), Nimba (*Azadirachta Indica*) mixed in cow ghee (clarified butter). All these are the antimicrobial drugs which are known to have antibacterial microbial properties, indicating it to be useful in Yagya.

Yagya (holy fire ritual) is of great significance in the vedic traditions and has been used from times immemorial as a potent method of physical, mental, and environmental purification that works at a very subtle level when performed in conjunct with specific chantings and certain herbal offerings. Yagya performed while chanting Gayatri mantra has shown to reduce particulate matter and electromagnetic radiations and also increased the antimicrobial activity against human pathogens present in the air and the environment.^[63-65] Moreover, regular Yagya along with chanting of Gayatri Mantra was shown to reduce stress and anxiety levels of the participants, helping them gain mental health and develop inner strength.^[66] See Table 1 for more details.

Yog and Meditation for Immunity

Although the renowned Indian philosophical system of Yog is considered to be a means for attaining salvation; however, this ancient body of wisdom can help mankind by uniting the body, mind, breath and the soul, manifesting overall health and longevity and allowing a wholesome experience of life to happen. It has been proven that yogic practices like Asana (Bodily Postures/Poses), Pranayama (Breathing Techniques), Dhyana (Meditation), and Yog-Nidra (Yogic relaxation/Psychic Sleep) not only affect the anatomical and physiological aspects of the human body, but also influence the mind and all its faculties positively, and help reduce stress and anxiety, along with an increase in physical stamina, improved health, and stronger immune system.^[67,68]

Yogic postures twist, compress and massage the internal organs, rejuvenating and energizing them, helping them function better. Asanas like Ushtra asana (camel pose) and Bhujang asana (cobra

Table 1: Research Articles on the effects of Yagya (holy fire rituals) on anti microbial activity, particulate matter, electro magnetic radiations

Study Title	Authors	Experimental Methods	Outcomes Assessed	Main Findings
Gayatri Mantra Chanting Helps Generate Higher Antimicrobial Activity of Yagya's Smoke. ^[63]	Ruchi Singh & Sunil Kumar Singh.	'Yagya' refers to the burning of wood, specific types of dried medicinal plant materials (hawan samagri) along with ghee with the 108 times Gayatri Mantra chanting.	Smoke fraction was captured for antimicrobial activity on human pathogens i.e Escherichia coli, Staphylococcus aureus, Pseudomonasaeruginosa, Bacillus subtilis, and Salmonella typhi.	"Antimicrobial data revealed that the 'smoke-extract' obtained from Yagya experiments with mantra chanting had higher zone of inhibition values compared to that of same experiment conditions except presence of mantra chanting suggesting an important role of the mantra chanting in Yagya for medicinal applications." ^[63]
Impact of Yagya on Particulate Matters. ^[64]	M. Saxena <i>et al.</i> 2018	Dry mango wood as Samidha, air purifying hawan samagri and cow's ghee were used for performing yagya at two different settings indoor and an outdoor samples of both the settings were recorded for PM analyses.	Measurement of the PM 2.5, PM 10, CO ₂ , temperature were taken using digital sampler. Three readings were taken for each day (before, during, and 2 consecutive after days) i.e. morning, noon and evening. The average was taken for analyses.	"The study showed that indoor environment of two of residents taken for study had presence of PM, which had trend of decrease after the Yagya at day 2" ^[64]
Yagya reduced level of indoor Electro-Magnetic Radiations (EMR) ^[65]	M. Saxena <i>et al.</i> 2018	Standard Yagya was performed with Hawan Samagri (herbal mixture) and measurement of the radiations was taken at different distances and time before and after the Yagya. Source of radiation was different for each place.	Electro-Magnetic-Radiations (generated from laptop, television, kitchen microwave and other sources) were measured using GM3120 Electric Magnetic Radiation Detector.	"Changes in EMR readings after Yagya were significant not only for short distances and short duration but also for long distances and longer duration. Yagya has a positive impact on the EMR inside the house and reduces its intensity to a level which is safe." ^[65]
A Case Study of the Effect of Yagya on the Level of Stress and Anxiety ^[66]	Nilachal & Piyush Trivedi 2019	Study conducted on 4 subjects for 30 days and levels of stress and anxiety were evaluated. Yagya was performed on all 30 days during dawn and dusk by all 4 participants. For Yaga, dried Cow dung patties of indigenous breed, hawan samagri and ghee were used along with Surya and Chandra Gayatri mantra, (12 oblations of both)	Biofeedback Galvanic Skin Response (GSR) and Sinha's Comprehensive Anxiety Test (SCAT) were used for measuring stress and anxiety levels respectively	"Subjects showed decrease in the anxiety level after 30 days of Yagy therapy. The Galvanic Skin Response also showed trend of reduction after the Yagya Therapy indicating beneficiary effect of Yagya Therapy on the patients. The deep inhalation and positive affirmation during each step of the Yagya might have helped the subjects to enhance mental health. The herbs we used are traditionally known for mental and stress reduction. Some of the herbs included are Brahmi, shankhpushpi, jatamansi, vach, etc (11-12). Also, it is a well-known fact that the substances, when taken in their vapor or gaseous form through the nostrils, have much greater efficacy." ^[66]

pose) involve stretching of the thoracic region and improve mobility of the lungs while Adho-Mukha shvanasana (downward facing dog) and other inverted and forward bending postures improve the flow of sinuses by flushing out excess mucus in the lungs.^[69] Yogic postures like Matsya-asana (fish pose), Sarvangasana (Shoulder stand pose), and Hala-asana (Plough pose) help to strengthen immunity as they directly activate the thymus gland^[70] which is a major contributor to a strong immune system.

Yogic breathing techniques help improve the pulmonary and cardiovascular functions by increasing lung capacity and improving circulation of blood,^[71] resulting in better expulsion of toxins and free radicals from the system. Pranayama like Bhastrika (bellows breath) and Kapalbhathi (frontal brain

cleansing) might also facilitate in clearing the nasal cavity and the thorax by throwing out excess mucus and accumulated phlegm of the lungs.^[70] Nadi-Shodhan-Pranayama (Alternate Nostril Breathing), Bhrumri-Pranayama (Humming Bee Breath), and Ujjayi-Pranayama (Victorious Breath) when performed slowly and rhythmically may help reduce stress levels along with lowering of blood pressure and heart rate simultaneously increasing metabolism and cognitive function.^[72-76]

Meditation is an inseparable part of Yog. All yogic practices aim to lead the mind into a calm and meditative state. Dhyana (Meditation) and Yog-Nidra (psychic sleep) help regulate the various hormonal secretions by down-regulating the constant HPA axis activation and resetting the psycho-neuro-immuno-endocrine pathways, thereby connecting the body mind and breath.^[68] Meditation

Table 2: Evidence base on role of YOG in enhancing immune system

Study Name/ Type	Authors/ Year/ Country	Study Population/ Study Groups/ Duration	Interventions used/ Experimental/ Control	Outcomes Assessed	Main Findings (quoted for original texts)
Effect of integrated yoga practices on immune responses in examination stress - A preliminary study. ^[80]	Gopal <i>et al.</i> , 2011 India	60 first year MBBS students Randomly assigned to Yoga & Control groups (30 each)	Yoga group: integrated yoga practices for 35 minutes daily for 12 weeks under a yoga teacher. (prayer, sukshma vyayam/micro exercises, sthula vyayam/macro exercises, asanas/postures, pranayam/breathing techniques, dhyana/meditation) Control group: No Yoga practice or stress management	Heart rate, respiratory rate, & blood pressure. Recent Stress Scale & Spielbergers State Anxiety score. Serum cortisol levels, IL-4, and IFN- γ levels.	“Control group showed a significant increase in physiological parameters during the examination stress as compared to yoga group. Likewise, the increase in serum cortisol and decrease in serum IFN- γ in yoga group was less significant than in the control group. Psychological stress indicators showed a highly significant difference in control group compared with significant difference in yoga group, during the examination.” ^[80]
Randomized trial of yoga as a complementary therapy for pulmonary tuberculosis. ^[81]	Naveen K. Vishweshwaraiah & Shirley Telles. 2003 India	pulmonary tuberculosis patients aged between 20 and 55 years	yoga (n=25) + anti-tuberculosis treatment breath awareness (n=23) + anti-tuberculosis treatment 6 hours per week, each session being 60 min.	symptom scores, bodyweight, FVC, FEV1, FEV1/FVC%, sputum microscopy, sputum culture, and postero-anterior view of the CXR	“The improved level of infection, radiographic picture, FVC, weight gain and reduced symptoms in the yoga group suggest a complementary role for yoga in the management of pulmonary tuberculosis.” ^[81]
Effects of prenatal yoga on women's stress and immune function across pregnancy: A randomized controlled trial. ^[82]	Pao-Ju Chen <i>et al.</i> 2016 Taiwan	94 healthy pregnant women at 16 weeks' gestation Randomly assigned to intervention (n=48) or control (n=46) groups Clinstat block randomization	20 weeks of Intervention Yoga Group: 2 weekly 70-min yoga sessions led by a midwife certified as a yoga instructor Control Group: Routine Prenatal Care	salivary cortisol and immunoglobulin A levels were collected before and after yoga every 4 weeks from 16 to 36 weeks' gestation.	“Yoga group had lower salivary cortisol & higher immunoglobulin A levels both immediately after yoga and also in the long term, than the control group. infants born to women in the intervention group weighed more than those born to the control group. Prenatal yoga significantly reduced pregnant women's stress and enhanced their immune function.” ^[82]
Gene expression profiling in practitioners of Sudarshan Kriya. ^[83]	Sharma <i>et al.</i> 2007 India	Experimental group: 42 practitioners of Sudarshan Kriya Yoga (practicing SKY for the past 1 year) Control group: 42 normal healthy controls not performing any conventional physical exercise or any formal stress management technique.	No Intervention involved: Comparative Study Controls & SKY practitioners were age- and sex- matched, with same socioeconomic status, had comparable body mass index, were vegetarians, and were nonsmokers, not taking any alcohol or any dietary supplements	Antioxidant enzymes, genes involved in oxidative stress, DNA damage, cell cycle control, aging, and apoptosis. (Glutathione peroxidase estimation, superoxide dismutase activity & Gene expression)	“A better antioxidant status both at the enzyme activity and RNA level was seen in SKY practitioners. This was accompanied by better stress regulation and better immune status due to prolonged life span of lymphocytes by up-regulation of antiapoptotic genes and prosurvival genes in these subjects.” ^[83]
Yoga stretching for improving salivary immune function and mental stress in middle-aged and older adults. ^[84]	Nobuhiko <i>et al.</i> 2018 Japan	23 adult women (age 60.4±10.4 years; body mass index 21.5±2.7 kg/m ²)	Yoga practice for 90 minutes Beginning with massaging their	Saliva flow rate, salivary SIgA concentration, SIgA secretion rate, Salivary cortisol concentration,	“Yoga stretching for 90 minutes was associated with a significant increase in SIgA secretion and a decrease in mental stress. Yoga stretching can reduce psychological stress and

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Table 2: Contd...

Study Name/ Type	Authors/ Year/ Country	Study Population/ Study Groups/ Duration	Interventions used/ Experimental/ Control	Outcomes Assessed	Main Findings (quoted for original texts)
		Crossover design: Yoga for 90 minutes one day, resting for 90 minutes the other day, both done at same time of different days. Measurements were carried out before and after each rest and yoga trial.	Legs, applying pressure to acupressure points for 20 minutes, followed by performing various yoga poses: the warrior, extended triangle, downward-facing dog poses etc. for 65 minutes. Ending with corpse pose, held for 5 minutes.	cortisol secretion rate, Salivary testosterone concentration, testosterone secretion rate, and Testosterone/ Cortisol ratio	enhance mucosal immune function. Therefore, performing yoga stretching consistently can prevent age-related immune suppression. ^{27[84]}
Effects of Meditation on the T-lymphocytes, B-lymphocytes and Natural Killer Cells Production. ^[85]	Nuamtanung <i>et al.</i> 2005 Thailand	11 Experienced meditators (5 males and 6 females) 10 new comers (4 males and 6 females)	1 hour of meditation daily for four months To be practiced by both groups	T-lymphocytes, B-lymphocytes and Natural Killer Cells	“CD 45+, CD 3+, CD 5+ and CD 8+ increased in the new comers and CD 3+, CD 8+, as well as CD (16+56)+ of NK-cells increased in the experienced meditators” ^{27[85]}
Regular Yoga Practice Improves Antioxidant Status, Immune Function, and Stress Hormone Releases in Young Healthy People: A Randomized, Double-Blind, Controlled Pilot Study. ^[86]	Sung-Ah Lim & Kwang-Jo Cheong, 2015 South Korea	Healthy University Students Control group (no yoga intervention) n=13 Yoga group (n=12)	Yoga practice once a week (for 90 minutes with instructor) for 12 weeks + daily practice at home (for 40 minutes) with the help of a DVD. Practices included asanas (bodily postures), pranayams (breathing techniques) & meditation.	Serum levels of oxidative stress parameters: Serum levels of antioxidant components: GSH, GSH-Px, GSH-Rd, GST, SOD	“Regular yoga practice remarkably attenuated oxidative stress and improved antioxidant levels of the body. Moreover, yoga beneficially affected stress hormone releases as well as partially improved immune function.” ^{27[86]}
Impact of yoga based mind-body intervention on systemic inflammatory markers and co-morbid depression in active Rheumatoid arthritis patients: A randomized controlled trial. ^[87]	Gautam <i>et al.</i> 2019 India	72 Rheumatoid Arthritis patients randomized to 2 groups Yoga group (yoga with DMARDs) Control group (DMARDs only) (DMARDs: disease modifying anti-rheumatic drugs)	8 weeks of yoga based MBI (Mind Body Intervention)	Disease activity score 28, erythrocyte sedimentation rate (DAS28ESR) Health assessment questionnaire disability index (HAQ-DI) Beck Depression Inventory II scale (BDI-II)	There was significant decrease in the severity of RA as seen by reduction in levels of various systemic inflammatory markers and reduction in the scores of BDI-II with DAS28ESR and HAQ-DI in yoga group. ^[87]
Comparative efficacy of a 12 week yoga-based lifestyle intervention and dietary intervention on adipokines, inflammation, and oxidative stress in adults with metabolic syndrome: a randomized controlled trial. ^[88]	Yadav <i>et al.</i> 2012-14 India	N=260 Younger adults, aged 20-45 years, diagnosed with Met S YBLI group (n=130) Yoga Based Lifestyle Intervention DI group (n=130) Dietary Intervention	12 weeks Yoga Based Lifestyle Intervention: Humming in Meditative posture, Shat Kriyas (Cleansing techniques), Suksham Vyayam (Loosening exercises), Static and dynamic exercises, Relaxation postures (in between asanas), Asanas (Postures- standing, sitting, prone & supine), Concentration techniques, Pranayama (breathing practices).	Anthropometric Measurements like Height, weight, BMI, BP, Pulse etc. HDL-C high-density lipoprotein cholesterol; HOMA-IR homeostasis model assessment-insulin resistance; IL-6 interleukin-6; TNF- α tumor necrosis factor- α ; SOD superoxide dismutase; 8-OHdG 8-hydroxy-2'-deoxyguanosine; TBARS thiobarbituric acid reactive substances.	“Overall, the YBLI inclusive of DI seemed to address the three key components in pathophysiological pathway of Met S, that is, adipokines, inflammation, and oxidative stress, and might be particularly beneficial in long term. The overall benefit remained comparable in the two intervention groups, though YBLI was more efficacious than DI in significantly reducing the oxidative stress as indicated by reduction in TBARS levels.” ^{27[88]}

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Table 2: Contd...

Study Name/ Type	Authors/ Year/ Country	Study Population/ Study Groups/ Duration	Interventions used/ Experimental/ Control	Outcomes Assessed	Main Findings (quoted for original texts)
Effect of Hatha yoga training on rhinitis symptoms and cytokines in allergic rhinitis patients. ^[89]	Chanta <i>et al.</i>	Thirty allergic rhinitis patients aged 18-45 years	The YOG group underwent a Hatha yoga training protocol for 60 minutes per session three times a week for 8 weeks. Hatha yoga training regimen: 10 minutes of warm-up followed by a workout for approximately 40 min followed by a cool down for 10 minutes. All exercises were yoga based and modifications of common yogic postures/ asanas.	General Physiological Characteristics like Height, weight, BMI, BP, Pulse etc., Rhinitis symptom scores, Peak nasal inspiratory flow, Nasal blood flow, Cytokines: IL-2 and IL-6	“After 8 weeks, the YOG group had increased peak nasal inspiratory flow (PNIF) and exhibited significantly decreased rhinitis symptoms and nasal blood flow (NBF) compared to pre-test. Moreover, the YOG group had significantly higher nasal secretion of interleukin (IL)-2 than the CON group. 8 weeks of Hatha yoga training had beneficial effects in allergic rhinitis by improved clinical allergic rhinitis and cytokine profiles” ^[89]

practices have been documented to reduce stress levels by increasing the secretions of melatonin - the happiness hormone^[77] and by reducing the secretions of serotonin - stress hormone.^[78]

Regular practice of cleansing techniques like Jal-Neti (nasal cleansing with saline water) may prove beneficial to prevent and manage diseases of the respiratory tract like asthma, pneumonia, bronchitis, pulmonary tuberculosis, etc., and may also help alleviate symptoms of allergies, colds and sinusitis.^[70,79]

A growing body of evidence about the use of yogic practices and meditation for people with disease conditions and those in healthy states suggests that regular practice of yog, meditation, and other mind-body medicine based interventions can help strengthen body immunity by lowering inflammatory and oxidative stress parameters while increasing anti-oxidant components and upregulating various defence markers of the immune system and in a way assist in protecting the masses from the wide-spreading COVID-19. For more details on some of these studies, see Table 2.

Conclusion

As the Chinese have done a few trials on their traditional medicine, much needs to be done in India to explore solutions seeded in our traditional systems of Ayurved and Yog. India needs to take a huge leap in trials in its traditional system just like China has done. Primary care physicians can play a vital role in providing this holistic approach and help improve patient care by suggesting options from these alternative systems of medicine, directing patients to experts in the field of Ayurved and Yog accordingly while continuing their standard pharmacological treatment and not dismissing the use of ayurvedic herbs and yogic practices. This article provides sufficient and good quality evidence regarding the efficacy of ayurvedic and yogic practices in immune strengthening and adds another stepping stone in

building a mindset of acceptance for the use of Indian systems of medicine, therapy and healing for patient care by the mainstream modern physicians. As per the WHO, India must lead to solutions regarding the current COVID-19 scenario. Hence, physicians need to explore the solutions and revamp its health care system with solutions ranging from strengthening family physician-based resources to the best of traditional based ancient Indian systems that are evidence-based. The evidence-based approach would provide an array of solutions from both modern medicine and ancient wisdom, the best of east and west.

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Conflicts of interest

There are no conflicts of interest.

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