

A systematic review on molecular, bio-chemical, and pathophysiological mechanisms of yoga, pranayama and meditation causing beneficial effects in various health disorders

Smitha R Varne¹, Balaji PA²

From, ¹CFN (Nutrition), C.C. in Integrative Medicine (University of Minnesota), Consultant Naturopathy and Yoga, Integrative Medicine and Nutritionist, Preksha Wellness and Yoga Center, ²ESH Hypertension Specialist, Preksha Wellness and Yoga Center, Bangalore, India. Sakaria Hospital, Former Associate professor, DR B R Ambedkar Medical College, Bangalore, India.

ABSTRACT

Background: Yoga is a psycho-somatic-spiritual discipline which includes changes in mental attitude, diet, and the practice of specific techniques such as yoga asanas (postures), breathing practices (pranayama's), and meditation to attain the highest level of consciousness. Since last two decades, there has been a surge in the research on yoga, and it is well established that regular practice of yoga, pranayama and meditation positively impacts overall health and diseases. But still, there is criticism that yoga has not much biological underpinnings. **Objectives:** This article was designed to present a comprehensive systematic review of the literature regarding the mechanisms of yoga, pranayama, and meditation on a variety of health disorders. **Materials and Methods:** A Medline search was done in Google chrome to review relevant articles in English literature on yoga articles focusing on the molecular, biochemical, and pathophysiological mechanisms of physiological effects of yogic practices. Data were extracted, constructed; issues were analyzed. **Results and Conclusion:** 89 articles (17 RCTs, 32 observational/interventional, 27 review/systematic/meta-analysis, 4 text books, 3 guidelines/ consensus statement, 6 unclassified articles) full filled the eligibility criteria, demonstrated the Physiological mechanisms by which yoga, pranayama and meditation resulting in beneficial effects in various neuropsychological, cardiovascular, respiratory, gastrointestinal, Endocrine/reproductive, and other disorders. We recommend future studies on yoga, pranayama and meditation to not only depict clinical health benefits but also simultaneously elucidate the possible physiological mechanisms behind such benefits.

Keywords: Pranayama, Meditation, Yoga, Health, Hypertension, Obesity, disorders.

Yoga is an ancient Indian discipline derived from Sanskrit word “yuj” performed to bring balance and health to the physical, mental, emotional, and spiritual aspects of the individual. It is long popular practice originated in India and has become increasingly more common in many parts of the globe. “Yoga” means union of one’s individual consciousness with the Universal Consciousness in a super-conscious state known as Samadhi. Pranayama means control of breath and is derived from Sanskrit words, namely, “prana,” which

means life energy or vital force, “ayama” means to prolong the breath. And Meditation involves allowing the mind to dwell on a series of words (called a mantra) given by the meditation teacher (Guru), with no effort [1,2].

In a review article by Balaji P.A et al, indicated practice of yoga and pranayama had considerable health benefits, including improved cognition, respiration, reduced cardiovascular risk, BMI, blood pressure, and blood sugar in diabetes mellitus. It also positively impacted immunity and joint disorders [2]. ICMR guidelines also suggests Yogic practices beneficially impact several

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Correspondence to: Balaji P. A, 31, Sneha Serenity Apartment, Second Main Road, Ambedkar Layout, Kavalbyrasandra, Bangalore 560032. **Email:** drpaba2@gmail.com, **Tel.:** +91 9844557294,

aspects of diabetes management, such as glycemic control, lipids, and body fat content, reduction in oxidative stress and blood pressure, improvement of pulmonary and autonomic function, mood, sleep, and quality of life [3]. Similarly, numerous reviews have contributed to the large body of research evidence attesting to the positive health benefits of yoga, pranayama, and meditation.

In an effort towards answering to the critics that, yoga Sana's beneficial effects have no evidence based scientific mechanisms and biological underpinnings, recently few researchers have focused on assessing changes in possible biomarkers (neurotransmitters, neurohormones, metabolites) along with clinical changes in patients with psychiatric disorders who practice yoga, pranayama, and meditation. For example, like changes in blood parameters such as brain-derived neurotrophic factor (BDNF) and oxytocin levels, and structural and functional changes in the human brain measured using magnetic resonance imaging as well as with newer investigating modalities such as functional near-infrared spectroscopy (fNIRS) and transcranial magnetic stimulation (TMS), which depicts regional blood flow and cortical inhibition respectively [4]. However, there is a definite need for more scientific work directed towards elucidating the mechanisms of such effects of yoga and pranayama on the human body in health and disease. Hence, this article is designed to present a comprehensive review of the literature regarding the mechanisms of yoga, pranayama, and meditation on a variety of health disorders.

METHODOLOGY

In order to provide broad understanding of mechanisms of yoga and pranayama, we searched MEDLINE English literature language published from unrestricted past till August 2023, through PubMed, Embase, PsycINFO, CINAHL and Complementary Medicine Database (AMED), IndMED, the Cochrane Database of Systematic Reviews, and PROSPERO for records of ongoing or recent to older systematic reviews. The eligibility criteria for screening were that the article should focus on yoga and pranayama/meditation and its physiological mechanisms. Article screening was carried out through the title and then abstract screening done to identify which articles have the potential to meet the expected criteria. After that a review of all articles considered significant was conducted.

Table 1 Search strategy of review

#1	Yoga[mesh] # pranayama # meditation#practice
#2	Yoga* OR Yogic OR Pranayam* OR Asana*
#3	molecular #1# mechanism OR #2 # biochemical

Quality of each article was carried out using the standard format of The Critical Appraisals Skill Program (CASP) scoring.

The criteria used to evaluate whether, each study is of good quality and a minimum risk of bias consisted of three components, namely whether the results of the study are valid? What are the positive and negative outcomes? Will the research outcomes benefit locally and globally? There is a total of 11 checklist items that are used to do the assessment with answer choices as yes/no reported. Data was extracted by making a summary of each article which includes, author, and year, country of origin of the study, type of study, sample (including the number of samples and inclusion and exclusion criteria), intervention procedure, results, discussion, conclusion, and limitations of the study. A total of 956 records were obtained through databases searching. After excluding duplicate records, two authors independently screened the titles and abstracts and selected 235 for full text assessment. We excluded 721 records, and finally 89 articles that meet all search criteria were selected, from where the issues were collated and discussed.

RESULTS AND DISCUSSION

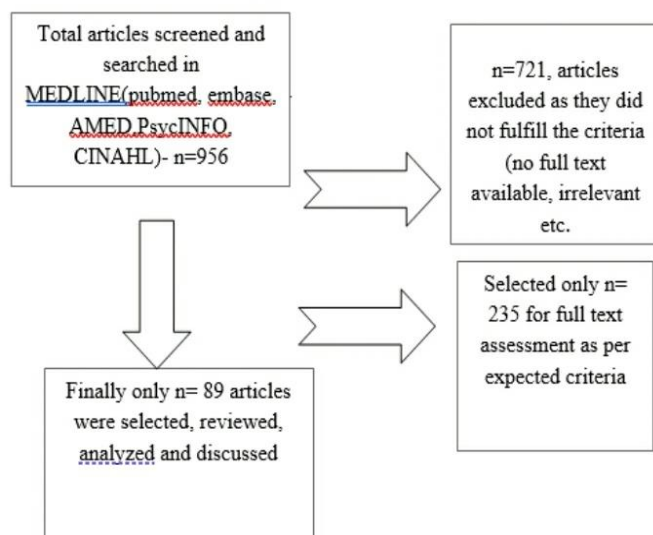
It is scientifically evident and already known that regular practices of yoga, pranayama and meditation positively impacts overall health and diseases. 89 articles (17 RCTs, 32 observational/interventional, 27 review/systematic/meta-analysis, 4 text books, 3 guidelines/ consensus statement, 6 unclassified articles) full filled the eligibility criteria and are discussed mainly, focusing on the Physiological mechanisms induced by yogic practices resulting in benefits on major organ systems and disorders (Search strategy shown in table and flow chart).

Neuropsychological disorders

With ageing, people's capacity to adapt and cope with stress gradually deteriorates. Some of the common problems are stress, anxiety, depression, schizophrenia, diminished cognition. Regular practice of yoga, pranayama, and meditation creates mental clarity and calmness, increases body- mind awareness, relieves chronic stress symptoms, relaxes the mind, centers attention, and sharpens concentration [5,6,7,8,9].

#4 Physiological #systematic review* OR systematic overview OR metaanalysis OR meta-analysis OR systematic* review OR systematic[sb] OR meta-analysis[pt]
 #5 respiratory #3 and #4 # hypothyroidism heart failure # stress or # anxiety
 #6 hypertension #type 2 diabetes #obesity # reproduction
 #7 dose reduction # usage # neuropsychological
 #8 health disorders and # or # diseases

Flow chart of search strategy



The possible mechanisms are

- γ -Aminobutyric acid (GABA)-ergic activity is reduced in mood and anxiety disorders. Regular practice of yoga and pranayama improve mood and ameliorate anxiety by increasing brain GABA levels [10].
- Yoga and meditation appear to modulate functions of the medulla oblongata, and is instrumental in regulating heart rate and respiration [11]. Yoga increases mammalian target of rapamycin (mTOR) signaling, which promotes the synthesis of proteins necessary for synapse formation and maturation; mTOR-dependent translational cascade may be one of the pathways representing neurogenesis and neuroplasticity [12,13,14].
- Yogasanas also alters the sirtuin-1 signaling pathway. Potential molecular mechanisms for enhancing neuroplasticity and alleviating depression by a) increasing sirtuin-1 include promotion of mTOR signaling, b) reduction of methylation in brain-derived neurotrophic factor (BDNF) transcription, and c) regulation of circadian rhythm by inhibiting CLOCK protein, a histone acetyltransferase [13,14,15].
- N Morgana M et al. suggested that pranayama significantly decreased states of anxiety and negative affect. The regular practice of pranayama modulated the activity of brain regions involved in emotional processing, particularly the amygdala, anterior cingulate, anterior insula, and prefrontal cortex and resting-state functional MRI (fMRI) showed significantly reduced functional connectivity involving the anterior insula and lateral portions of the prefrontal cortex of brain [16].
- S campanelli et al. postulated that specific neurons from pre-BötC could be affected by the voluntary control of respiration during yoga and pranayama, thus stimulating less the locus coeruleus and reducing anxiety-related states. Also, considering the prolongation of the respiratory cycle or the increase in nasal airflow during these practices, it is possible that the olfactory bulb could exert a modulatory influence on the frontal lobe and limbic structures during, resulting in long-term neuro plasticity [17].
- A study involving schizophrenic patients, found that 4 weeks of practising yoga, pranayama and meditation increased plasma oxytocin levels, socio-occupational functioning and facial emotion recognition in the yoga group compared with the control group. Six months of add-on yoga nidra in women with menstrual disturbances demonstrated significant decrease in serum prolactin levels at baseline and post-trial and was associated with significant improvement in mean scores of anxiety, depression, physical and psychological well-being [4].
- Cortical inhibition, which is a gamma-aminobutyric acid (GABA)-mediated activity, has been shown to be abnormal in patients with major depression and obsessive-compulsive disorder. 12 weeks of yoga practice compared to walking depicted increased GABA concentrations (measured by magnetic resonance spectroscopy) in the left thalamus, which matched with the subjective reports of improvements on mood and anxiety scales [18].
- Another study using TMS (transcranial magnetic stimulation) showed that healthy individuals had significant enhancement of the cortical silent period (CSP) (a TMS-derived measure of cortical inhibition mediated by GABAB sub receptors), with a possible dose-response relationship with the number of yoga hours. These biomarker changes, such as the TMS

findings, have been depicted in healthy individuals only, but are more likely to be relevant as of the main mechanisms in patients with psychiatric disorders [19].

The Molecular and Epigenetic Effects of Movement

Meditations like yoga: Yoga, pranayama, and meditation can improve attention, self-control, concentration and mindfulness by helping to achieve inner silence through yogic movements. Few studies have demonstrated the physiological effects of these practices at the molecular level [20].

- a. Longitudinal observations have revealed that Yoga was able to induce gene expression changes in PBMCs (peripheral blood mononuclear cells) [21]. Similarly, differential expression of genes related to type I interferon response and inflammation was demonstrated following daily Yoga in a population of breast cancer survivors [22].
- b. Yoga can help cope with stress conditions as correlated with reduction of serum cortisol via the HPA axis [23]. Cortisol Awakening Response (CAR) can be a better measure of stress resilience. In a study by Cahn et al, CAR appeared significantly increased after training, and also BDNF, a key central regulator of neuroplasticity, was also found to increase following yoga/pranayama practice both in healthy [23,24]. And depressed patients [25]. Since BDNF (Brain Derived Neurotrophic Factor (BDNF) can cross the blood-brain barrier, it is fair to assume that peripheral BDNF levels may reflect those in the brain [26]. These results could be suggestive of that Yoga, pranayama and meditation practices can counteract neurodegenerative processes resulting from various types of stress, by reducing cellular aging and preserving and boosting neuroplasticity in the brain.

Beneficial effects of Sitting Meditations: There are many ways of doing meditation, like, Transcendental Meditation (TM), Zen meditation, Vipassana, Buddhist meditation, Sudarshan Kriya (SK), Pranayama and others. All methods of meditations help in achieving mindfulness, a state of moment-to-moment non-judgmental awareness of the actual experience, possibly reached through a state of inner silence. These meditations have been studied from the molecular point of view and it has been found that they can influence the levels of several biomarkers like hormones and neurotransmitters, intermediate metabolites and neuroendocrine factors affected by stress and relevant to disorders [27,28]. TM, SK, and Zen meditations have clearly demonstrated influence levels on cortisol, serotonin, melatonin, epinephrine and norepinephrine, gamma amino butyric acid (GABA), glutamate, and dehydroepi and rosterone levels. (DHEA) [29].

Care giver stress: In last few decades, psychological distress among caregivers of patients with neurological, neurosurgical, and mental disorders has exponentially increased. Non curable, prolonged hospital stay, poor knowledge about illness, illiteracy, and poverty could be some of the other reasons for stress. The effect of caregiving for someone with illness brings the risks of mental ill health to the carer in the form of emotional stress, mood disturbances, or clinical depression. The practice of yoga decreases caregiver stress with a positive impact on caregiver mental health. Additionally, yoga and meditation plays an important role in bringing down caregiver burden and depression [30]. Hence, practice of yoga, pranayama and meditation can prevent initiation of drugs/medications to tackle stress, anxiety and depression in vulnerable population.

Cardiovascular diseases: Common disorders are hypertension, coronary artery disease, arrhythmia, heart failure. Many studies have suggested that regular yoga practice with breathing exercises could increase lung volume, decrease heart rate, and blood pressure, help regulate the parasympathetic and sympathetic nervous systems, lower anxiety, and physical endurance [31-35]. Pranayama causes reduction of heart rate and rate pressure product implying better autonomic control, reduced oxygen consumption and rest to the heart [36]. Multiple researchers have demonstrated regular practice of yoga and pranayama causes significant reduction in both systolic and diastolic blood pressure among hypertensive patients [37-42].

The possible mechanisms are

- a. The mechanism by which yoga, pranayama and meditation reduces blood pressure could be by reduction in sympathetic overactivity, facilitating autonomic balance, enhancing baroreflex sensitivity, and stabilization of chemoreceptor responses [43].
- b. Pranayama beneficially reduces the indices of ventricular repolarization dispersion in patients with arrhythmia [44].
- c. Yoga interventions can potentially improve the electrical stability of the heart by maintaining ANS balance and lessening episodes of atrial fibrillation (AF). Atrial fibrillation symptoms (palpitations, shortness of breath, dizziness, and fatigue), stress, depression, and anxiety decrease and thus improving the health-related QOL (quality of life) [45].
- d. Yoga practice for 3 months demonstrated a significant enhancement in left ventricular relaxation period suggesting an improvement in diastolic function and effective in reducing Heart rate and rate pressure product (RPP) [46].

- e. The effects of yoga for Heart Failure patients include a reduction of inflammatory markers, blood pressure, pain, and a decrease in implantable cardioverter defibrillator firings [47].

Type 2 Diabetes mellitus: Many studies have shown a significant decrease in FBS, PPBS, HbA1c values in patients who underwent the 3 or more months of yoga and pranayama practice [48-51].

The possible mechanisms are

- Rejuvenation of cells of pancreas due to abdominal stretching during yogasanas, which may increase utilization and metabolism of glucose in peripheral tissues, liver, kidney, and adipose tissues through enzymatic process.
- More active practices followed by relaxing type, lead to deeper relaxation than relaxing practices alone, can result in neuroplasticity bringing about changes in the hypo-pituitary-pancreatic axis.
- Muscular relaxation, development and improved blood supply to skeletal muscles might enhance insulin receptor expression on muscles causing increased glucose uptake and thus reducing levels of raised blood sugar.
- Yogasanas can lead to enhancement in the sensitivity of the b-Cells of the pancreas to the glucose signal and also the improvement in insulin sensitivity which in turn can be due to the cumulative effect of performing the postures [51-55].
- Regeneration of pancreatic beta cells could occur by yoga exercises that promote blood circulation in the region of the pancreas and yoga asanas that stimulate the meridian of pancreas also could assist in some diabetic patients.

Thyroid disorders: Studies have demonstrated yoga and pranayama significantly improved in TSH, and symptomatic wellbeing among hypothyroidism patients [56].

The possible mechanisms are

- Regular practice of Yoga postures like shoulder stand (Saravangasana), plow pose (Halasana), fish pose (Matsyasana), camel pose (Ustrasana), cobra pose (Bhujangasana), bridge formation pose (Sethubandhasana), and bow pose (Dhanurasana) can enhance balance and regulate the functions of the thyroid gland by improving its blood circulation, squeezing out stagnant colloid secretions and improving strength of neck muscles.
- Pranayama like Ujjayi results in voluntary constriction of glottis and throat region thereby causing stimulation

and relaxation of the thyroid gland. Various other pranayama like Bhramari cause voluntary prolongation of breath, leading to stretching of the thyroid gland and also by rebalancing metabolism and improving reflex pathways within the throat could stabilize thyroid imbalance [56,57].

Similarly, as regular practice of yoga and pranayama result in increased parasympathetic activity and decreased sympathetic overactivity, which in turn can be effective in reducing the dose of betablockers required to control the increased heart rate and anxiety among thyrotoxic patients.

Obesity and dyslipidemia: Many research projects focusing on effects of yoga and pranayama, have depicted significant reduction in BMI and lipid levels.

The possible mechanisms are

- The sequential slow and less-strenuous movements of yoga positively impacts the hypothalamic-pituitary axis response, to stress and this could be the main basis for the reduction in weight among obese patients. Regular yoga practice can induce secretion of anti-adipogenic adipokines and suppress adipogenic and inflammatory adipokines by regulating transcription of microRNA (miRNAs) [58].
- The improvement in the lipid profile among obese patients could be due to. 1) Increased hepatic lipase and lipoprotein lipase at cellular level, which alters the metabolism of lipoprotein and thus enhances the uptake of triglycerides by adipose tissues. 2) Meditation brings about a balanced metabolic state and decreases the stress-induced sympathetic over activity which leads to overcome stress that ultimately results in lowered cortisol levels and inflammatory lipoproteins [59,60].

Reproductive functions and pregnancy: Studies have shown that practice of yoga and pranayama modulates neuro-endocrine axis resulting in beneficial changes. Schmidt et al. found a reduction in urinary excretion of adrenaline, noradrenaline, dopamine, and aldosterone, a decrease in serum testosterone and serum luteinizing hormone levels and an increase in urinary cortisol excretion. Kamei et al., found changes in EEG waves and blood levels of serum cortisol during performance of yoga in 7 yoga experts and found that alpha waves increased and serum cortisol decreased [61,62].

Narendran et al., found that yoga practices including physical postures, breathing, and meditation practiced by pregnant women 1 hour daily resulted in decrease in

preterm labor, and decrease in IUGR (intrauterine growth retardation) either in isolation or associated with PIH (pregnancy induced hypertension), with no increased complications. Beddoe et al., found that women practicing yoga in their second trimester reported significant decrease in physical pain from baseline to post yoga practices. Pregnant women in their third trimester showed greater reductions in perceived stress and anxiety [63,64].

Balaji P A et al. have demonstrated that yoga and pranayama significantly decreased blood glucose levels which in turn can prevent adverse maternal and fetal outcomes of Gestational diabetes mellitus [65]. From the above findings, it indicates that yoga and pranayama can be used to prevent or reduce obstetric complications.

Respiratory system: common disorders are bronchial asthma, chronic obstructive airway disease, chronic bronchitis. Yoga and pranayama practices cause an increase in vital capacity, tidal volume, FEV1(forced expiratory volume), FEV1/FVC(forced vital capacity)ratio, expiratory reserve volume, breath holding time and many other pulmonary parameters [66,67].

A study among asthmatic patients, depicted about 55% decrease in usage of rescue medication and physical wellbeing in the yoga group [68]. Another study showed yoga and pranayama practices reduced the number of asthma attacks and consequently reduction of frequency of usage of inhalers and lesser dependency on inhalers [69].

The possible mechanisms are

- a. Yoga and Pranayama practices, stretches the lung tissue producing inhibitory signals from action of slowly adapting receptors and hyperpolarisation. These inhibitory signals from cardiorespiratory region involving vagi could synchronize neural elements in the brain leading to changes in the autonomic nervous system; and a resultant condition characterized by reduced metabolism and parasympathetic predominance. Pranayama also modified various inflatory and deflatory lung reflexes and interact with central neural element to bring new cardiorespiratory homeostasis in the body [70,71].
- b. Improvements in perception of dyspnea may result from a decrease in sympathetic reactivity achieved by regular yogic and pranayama practices, promoting broncho-dilatation by correcting abnormal breathing patterns and reducing muscle tension in inspiratory and expiratory muscles. Improved breathing patterns could widen bronchioles so that larger numbers of alveoli can be efficiently perfused and oxygenated. Continuous

Yoga and Pranayama practices stretch lung tissue, alleviating dyspnea by decreasing dynamic hyperinflation of the rib cage and recuperating gas exchange, enhancing respiratory muscles' strength and endurance, and optimizing thoracoabdominal patterns of breathing. Modifications in efferent vagal activity can affect the caliber of airways thereby reducing dyspnea [72-75].

- c. Fatigue scores showed improvement can be explained by various interrelated factors such as 1) Yogasanas make muscles are toned, energy is conserved and sympathetic activity balanced, while mental relaxation and greater parasympathetic function affect cardiorespiratory activity, relax the vasomotor center, and reduce pulse rate, which finally leads to reduced feelings of fatigue. 2) Pranayama helps in the optimal utilization of the lungs, enhancing ventilatory function, reducing oxygen debt, improving gas exchange, and thus preventing physical exhaustion.

Gastrointestinal system: Common disorders are gastroesophageal reflux disease, irritable bowel syndrome, constipation. Multiple research projects have demonstrated beneficial effects of yoga and pranayama practices on gastrointestinal disorders like gastroesophageal reflux disease (GERD), irritable bowel syndrome and constipation [76,77].

The possible mechanisms are

- a. During yoga practice, a relaxation response could to be mediated through a reduction in adrenaline and response from end-organs. Physiological changes in this relaxation response include simultaneous lowering of pulse rate, blood pressure, and respiratory rate, which are opposite manifestations of stress. Increase in stress has shown to increase gastric-acid secretion, this is a direct risk factor for developing gastric and duodenal ulcer. On the other hand, as yoga decreases the stress response of the digestive tract, this could be a potential mechanism of action of treatment for GERD and peptic ulcer [76,77,78].
- b. Longer duration of practice of these yoga and pranayama could increase vascularity of gastrointestinal tract and associated glands to meet the metabolic demand resulting in sequential ischemia and high blood flow, can have stimulating effect on smooth muscles and pacemaker cells of GIT. Also there may be biochemical alteration in brain gut axis due to yoga practices affecting bowel motility and constipation.
- c. Also, continuous practice of yoga can cause increase in vascularity of tissues by process of angiogenesis to meet the metabolic demand of tissues and this

increased blood supply will lead to increased nutrition and thereby strengthening of gastrointestinal muscle. Yoga, pranayama and meditation can influence the levels of various gastrointestinal hormones affecting bowel movement and defecation, like increased production of endorphin which can decrease constipation. Yogasanas result in action of pelvic floor muscle, which in turn influences act of defecation. Uddiyanabandha, Pawanmuktasana massage the abdominal viscera and Mahabandh is combination of moolbandha and uddiyanabandha. These pelvic floor muscles exercises, strongly influence the process of defecation and thereby ameliorates constipation [79,80,81].

Arthritis: Non-steroidal antiinflammatory drugs (NSAIDs), including cyclo-oxygenase II inhibitors are one of the main stay of drug treatments. They reduce both pain and inflammation effectively, but their long-term usage has been associated with increased risk for gastrointestinal bleeding, increased blood pressure, congestive heart failure, renal failure and other major adverse effects. Hence, a large number of studies have shown Non pharmacological methods like practices of yoga and pranayama generated significant improvement in morning stiffness, pain, swelling, and overall wellbeing among rheumatoid arthritis patients [82-85].

The possible mechanisms are

- a. A study involving rheumatoid arthritis (RA) patients, depicted that disease activity significantly decreased in both groups after 3 months, but it was reduced more in yoga group which was statistically significant ($p < 0.05$). In both Yoga group and Control group IL-1 α , IL-6, TNF- α , and cortisol decreased after 12 weeks, but IL-1 α and cortisol decreased more significantly in Yoga group than in Control group [86].
- b. Yoga practice can significantly reduce disease activity, normalize biomarkers of the psycho-neuro-immune axis with associated changes in gene expression patterns, and improved QOL probably by inducing molecular remission in RA via influencing its pathobiology by targeting mind-body communications. Long term practice of yoga, pranayama and meditation exhibited downregulation of T cell receptor signaling and inflammatory response pathways associated with NF κ B, RELA, TNFR2 transcription factors [87,88].

Orthostatic hypotension (OH) and vasovagal syncope (VVS): A systematic review conducted by Balaji P A et al, involving seven articles (3 RCTS, 3 Observational/interventional, 1 review) that full filled

search criteria, demonstrated that 6 yogic practices can have positive impact in attenuation of orthostatic hypotension and prevent frequency of recurrence of VVS [89].

The possible mechanisms

- a. The beneficial effects of yoga and pranayama could be through combined central and peripheral mechanisms, which comprise various isotonic postures involving different muscle groups leading to enhanced muscle and vascular tone in addition to building muscle strength, which can not only blunt the venodilatation phase of a syncope episode but also increase the venous return. Further, pranayama breathing and relaxation techniques have been shown to increase the parasympathetic tone and improve autonomic balance which could potentially decrease the sympathetic overdrive phase and interrupt the activation of the c-mechanoreceptors, which is a crucial step in the syncope.
- b. Gradual correction of orthostatic imbalance, could be because of Yoga postures over neuromuscular reflex malfunction that occurs in vasovagal syncope. The yogic postures focus on strengthening neuromuscular reflexes in the quadriceps and the calf muscles, which can accelerate the blood circulation and venous return, thus preventing pooling of blood in the lower limbs.
- c. Yogic practices cause modulation and optimization of sympathetic activities in stressful situations thereby immediately restoring equilibrium, which in turn avoids intervention of inhibitory parasympathetic system in patients with orthostatic hypotension.

Thus, the various health benefits of yoga, pranayama and meditation among patients with different types of disorders could be related to changes in the levels of various molecules, hormones, enzymes, neurotransmitters, autonomic balance, and modulation of gene expression and reduction of inflammatory markers.

CONCLUSION

89 articles (17 RCTS, 32 observational/interventional, 27 review/systematic/meta-analysis, 4 text books, 3 guidelines/ consensus statement, 6 unclassified articles) full filled the eligibility criteria and demonstrated the Physiological mechanisms by which yoga, pranayama and meditation can cause beneficial effects in health and disease and it is fair to state that such practices can be beneficial in the prevention and cure of many disorders. We recommend future studies on yoga, pranayama and meditation to not only depict clinical health benefits but

also simultaneously elucidate the possible physiological mechanisms behind such benefits.

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