

## Health Impacts of Yoga and Pranayama: A State-of-the-Art Review

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### ABSTRACT

Thousands of years ago yoga originated in India, and in present day and age, an alarming awareness was observed in health and natural remedies among people by yoga and pranayama which has been proven an effective method for improving health in addition to prevention and management of diseases. With increasing scientific research in yoga, its therapeutic aspects are also being explored. Yoga is reported to reduce stress and anxiety, improves autonomic functions by triggering neurohormonal mechanisms by the suppression of sympathetic activity, and even, now-a-days, several reports suggested yoga is beneficial for physical health of cancer patients. Such global recognition of yoga also testifies to India's growing cultural influence.

**Key words:** Anxiety, cancer, hypertension, pranayama, stress, yoga

### INTRODUCTION

*All the orthodox systems of Indian Philosophy have one goal in view, the liberation of the soul through perfection. The method is by Yoga.* - Swami Vivekananda.<sup>[1]</sup> Yoga is an ancient discipline designed to bring balance and health to the physical, mental, emotional, and spiritual dimensions of the individual. It is long popular practice in India that has become increasingly more common in Western society. "Yoga" means union of our individual consciousness with the Universal Divine Consciousness in a super-conscious state known as *Samadhi*.<sup>[1,2]</sup> The first book of humankind, *Rigveda*, mentions about yogic meditation by the wise, while *Yajurveda* exhorts us to practice yoga for enhancing mental health, physical strength, and prosperity. Upanishads are replete with yogic concepts. In addition, yoga-related terms like *pranayama* and *samadhi* occur repeatedly in *Bhagavad-Gita*. Ancient Indian *rishis* understood that performing *Raja-yoga* (procedure of concentration to liberate soul or *atma* from the bondage of *maya* into *paramatma*) always need a healthy body – "*Sharirmadyam, khalu dharma sadhanam.*" So they developed "*Hatha yoga,*" which includes *asana, mudra, pranayama,* etc. "*Gharanda samhita*" said there were 84 lakh asanas from which 16 000 were best and only about 300 are popular. "*Hathayoga-pradipika*" again differentiates all asanas into four basic classes – *sidhyasana, padmasana, sinhasana,* and *vadrasana.* Besides, asana may be of

two types – *dhyanasana* (a posture keeps spinal cord free and center of gravity shifts to other part like ribs) and *shasthyasana* (to get healthy body).

## YOGA: THE HISTORIC OUTLOOK

In Indian religions, yoga (from the Sanskrit word meaning “yoking” or “joining”) is “the means or techniques for transforming consciousness and attaining liberation (*moksha*) from karma<sup>[3]</sup> and rebirth (*samsara*).”<sup>[4]</sup> It is “a practice by means of which a spiritual seeker strives, (1) to control nature to make the soul fit for union with the Oversoul (the true Self or *Atman-Brahman* or “God”), and (2) to attain union with God and thus the liberation of the soul from the rounds of rebirth and death.”<sup>[5]</sup> Yoga is popularly understood to be a program of physical exercises (*asana*) and breathing exercises (*pranayama*).

Yoga began in India as early as 3000 B.C. [Table 1], according to archeological evidence.<sup>[6]</sup> It emerged in the later hymns of the ancient Hindu texts (Upanishads or Vedanta) (600–500 B.C.). It is mentioned in the classic Indian poem *Mahabharata* (400 B.C. - 400 A.D.) and discussed in the most famous part of that poem, the *Bhagavad Gita*. Yoga was systemized by Patanjali in the *Yoga Sutras* (300–200 B.C.). Patanjali defined the purpose of yoga as knowledge of the true “Self” (God) and outlined eight steps for direct experience of “*Self*.”

Yoga, as practiced and taught in India, entered the Western world in the 19th century with the translation of basic yogic texts. Following attendance at the World Parliament of Religions in Chicago in 1893, Swami Vivekananda introduced yoga to the USA. He lectured widely on the practice, founded the Vedanta Society, and authored many books.<sup>[7]</sup> Then yoga was promulgated in the West by the numerous teachers who studied in eastern countries (principally India), many of whom immigrated to America in the early 20th century. In the 20th century numerous versions of yoga were developed and taught. Numerous books aided the growth of a yoga practicing community in the USA. In the 1950s, “an almost faddish burst of interest in hatha yoga” occurred in the USA. During the decade, yoga spread through health and beauty salons.<sup>[8]</sup> Indian teachers immigrated to the USA during this period, founding centers and publishing books that helped to popularize the movement.

In the 1950s and 1960s several important books were published on yogic techniques and then in 1970s yoga rapidly expanded, with the founding of numerous yoga centers and professional associations. Yoga became especially popular among adherents of New Age ideas.<sup>[9]</sup>

## ASTHANGA YOGA

Yoga (*asthanga*) is often depicted metaphorically as a tree and comprises eight aspects, or “limbs” [Patanjali codified the ancient marvel of yoga as *asthanga* which is one of the six schools of Indian philosophy and is known as *Yoga Darshan*<sup>[2]</sup>]: *yama* (universal ethics), *niyama* (individual ethics), *asana* (physical postures), *pranayama* (breath control), *pratyahara* (control of the senses), *dharana* (concentration), *dyana* (meditation), and *samadhi* (bliss).<sup>[10]</sup> Each limb is connected with the whole, in the same way that bodily limbs are all connected [Table 2]. If someone pulls the body by the leg, the rest of the body will automatically follow. In the same way, when one pulls one of the eight limbs of yoga, the others will naturally come. They are not stages to be achieved in succession.<sup>[10]</sup>

## YOGA AND PRANAYAMA: BENEFICIAL HEALTH IMPACTS

Many people in the USA today claim to practice yoga for its health benefits without consciously adopting Hindu religious perspectives which underlies the practice and usually become apparent in more advanced stages of instruction. Elementary courses of *hatha yoga* focus on physical exercises consisting of various postures and breathing techniques. A growing body of research evidence supports the belief that certain yoga techniques may improve physical and mental health through down-regulation of the hypothalamo pituitary adrenal (HPA) axis and the sympathetic nervous system.

The stress and stress-induced disorders like hypertension and angina are fast growing epidemics and bane of “modern” society. The holistic science of yoga is the best method for prevention as well as management of stress and stress-induced disorders. Numerous studies have shown yoga to have an immediate down-regulating effect on both the HPA axis responses to stress. Effectiveness of yoga against stress management is well established.<sup>[14]</sup>

**Table 1:** The history of yoga and world religions

Chronology	Major event	
10 - 5000 BC	First Civilized Cities Indus valley	Paintings found of Yoga Meditation in archaeological excavations in the Indus valley. This sophisticated culture developed around the Indus river and the long gone Saraswati river in northern India, on the border towards Pakistan.
3000 BC	Stone Seals Yoga Poses	Earliest archaeological evidence of Yoga's existence could be found in stone seals which depict figures of Yoga Poses.
2008 BC	<b>The Vedas Period of Yoga</b>	A collection of hymns, mantras, and Brahmanical rituals that praised a greater being. Yoga is referred to in the book as yoking or discipline without any mention of a practice or a method to achieve this discipline. The <i>Atharva Veda</i> too mentions yoga with a reference to controlling the breath.
1500 BC 800 BC	Birth of Hinduism and Judaism <b>Upanishads: Pre-Classical Yoga Period</b>	The Upanishads explains the importance for human to learn and understand more about the ultimate unity of all things. Furthermore, the Upanishads speak about Brahman (universal spirit) and Atman (individual) and emphasize the characteristics of both Brahman and Atman.
700 BC	Ancient Greece Civilization Established	
509 BC	Birth of Gautama Buddha	
500 BC	Bhagavad Gita	Lord's Song was created and this is currently the oldest known Yoga scripture. It is devoted entirely to Yoga and has confirmed that it has been an old practice for some time.
100 BC	<b>The Yoga Sutras: The Classical Period of Yoga</b>	Written by Patanjali around the second century, it was an attempt to define and standardize Classical Yoga. It is composed of 195 aphorisms or sutras (from the Sanskrit word which means thread) that expound upon the Raja Yoga and its underlying principle, Patanjali's Eightfold path of Yoga (also called Eight Limbs of Classical Yoga or <i>Ashtanga</i> ).
30 AD	Birth of Christianity	The Death of Jesus Christ. 590 AD birth of Catholicism - 1518 AD Birth of Protestantism.
570-610 AD	Origin of Islam: Birth of Mohammed	
1650 AD	Tibetan Buddhism: Rise of Dalai Lama	
1893 AD	Yoga Introduced in the United States	Modern yoga was introduced by young Swami Vivekananda in the Parliament of Religions which was held in Chicago in 1893.
1931 AD	Krishnamacharya	Mysore, India, this is where Krishnamacharya developed and taught what is now known as <i>Ashtanga Vinyasa Yoga</i> . It was during this period that he taught. Pattabhi Jois, B K S Iyengar and T K V Desikacharar Krishnamacharya's son) and sent them out to spread the teachings of yoga.

It was also found that brief yoga-based relaxation training normalizes the function of the autonomic nervous system by deviating both sympathetic and parasympathetic indices toward more "normal" middle region of the reference values.<sup>[15]</sup> Studies show that yoga decreases levels of salivary cortisol,<sup>[16,17]</sup> blood glucose,<sup>[18,19]</sup> as well as plasma rennin levels, and 24-h urine nor-epinephrine and epinephrine levels.<sup>[20]</sup> Yoga significantly decreases heart rate and systolic and diastolic blood pressures.<sup>[20-22]</sup> These studies suggest that

yoga has an immediate quieting effect on the HPA axis response to stress. While the precise mechanism of action has not been determined, it has been hypothesized that some yoga exercises cause a shift toward parasympathetic nervous system dominance, possibly via direct vagal stimulation.<sup>[23]</sup> Shapiro *et al.*<sup>[24]</sup> noted significant reductions in low-frequency heart rate variability – a sign of sympathetic nervous system activation – in depressed patients following an 8-week yoga intervention. Regardless of the pathophysiologic

**Table 2: Astanga yoga**

<i>Yamas – Universal Principles</i>	The yamas can be thought of as the ethical restraints that are necessary for achieving harmony with other beings. The first limb of Patanjali's eight limbs of yoga is Universal Principles or Yamas and this includes five principles. <sup>[10]</sup>
<i>Ahimsa (Non-Violence)</i>	If a closer look has been taken at nature one can see that animals are not violent. Animals in the wild, living in their natural habitat, do not kill each other for the sake of killing. They kill when they are hungry and when they want to eat. Human, however, kill each other in the name of for example God, country, race, religion. Ahimsa involves consciously or unconsciously avoiding violence. Ahimsa is a state of consciousness in which one consciously decides to not kill any animal or any form of life on the planet. Violence is not only those acts which are committed by us directly, but include the encouragement of other people to be violent or approving of the violence of another person. These are all acts which come from a lack of wisdom as well as a lack of understanding about the sorrow that such acts bring to those who commit them. <sup>[10]</sup>
<i>Satya (Truth)</i>	Truth is not just about being blunt and speaking truthful words, but is about total commitment to truth and truth is a quality of consciousness. Being established in truth does not mean that one won't encounter failures, but one's actions become fruitful in whatever he does. Everything in this universe is constantly changing. People are changing, their bodies are changing, their cells are changing, attitudes and emotions are constantly changing. The whole world is in a state of flux and change. However, there is something within one which is not changing, the, this is called <i>satya</i> . <sup>[10]</sup>
<i>Asteya (Non Stealing)</i>	Stealing not only includes physical stealing, like stealing an object, but can also be mental. Stealing in this way is connected to jealousy whilst non-stealing eliminates jealousy. Having even just the smallest intention to steal can keep one poor. Non-stealing allows all the wealth to come to you in its many shapes and forms. Most of the time poverty is self-made and the intention to steal sends people's luck down the drain. <sup>[10]</sup>
<i>Brahmacharya (Celibacy)</i>	Brahmacharya does not only refer to physical celibacy, although celibacy does bring enormous strength. Brahmacharya knows one's vast nature, knowing that one's sense organs cannot bring one joy and not thinking that you are just the body. A limited mind, full of lust, is the perfect pot in which to brew negative emotions such as jealousy, greed, and hatred. Great strength comes when one sees himself as more than just the body, as consciousness or <i>Brahma</i> . <sup>[10]</sup>
<i>Aparigraha (Non-Accumulation)</i>	Practicing non-accumulation makes it easy to receive the kind of knowledge that cannot be acquired through books. Knowledge of the "self" and of one's greater potential comes easily. Through accumulation, stinginess, or selfishness, there is no space in the consciousness for expansion and the mind becomes obsessed with fear and accumulating. That which is scattered will receive more, but that which had held onto will taken one away. Giving in this way removes past impressions and karmas of the mind and the mind becomes freer, but holding onto things and being selfish brings with it a very constricted and contracting consciousness which prevents you from being happy. <sup>[10]</sup>
<i>Niyamas - Observances</i>	As with the universal principles or yamas, there are five niyamas. The niyamas are the actions necessary for achieving balance within oneself.
<i>S a u c a (Cleanliness)</i>	One aspect of cleanliness refers to physical cleanliness and being clean both from within and without. Water is the great purifier. Drinking water removes toxins from within the body while external cleansing cleans the energy field around the body (aura) and settles the life force (prana) throughout the body. Other aspects of cleanliness include cleanliness in one's environment, both within and outside the home/work environment, and in the physical appearance. Internal cleanliness also includes cleanliness of the mind, which can be achieved through the practice of meditation. Through <i>sauca</i> the intellect is purified and the mind becomes harmonious. <sup>[10]</sup>
<i>Santosa (Contentment)</i>	Contentment is a state of mind that involves being content with what one is getting in life, irrespective of whether he judges it to be good or bad, knowing and realizing that it is for the benevolence and growth even if it appears otherwise at the time. <sup>[10]</sup>

(Continued)

**Table 2:** (Continued)

	<i>Tapas</i> (Forbearance of Opposites/ Perseverance)	Often when one complains against life, is not observing <i>tapas</i> in life. Through complaining one not only reduces the joy but also lose the benefit that comes with not complaining. By not complaining one becomes strong. When the body and the senses become strong, one can withstand any difficulty and becomes very strong. Being able to tolerate opposites one not only becomes very strong in the body but also in the mind. <sup>[10]</sup>
	<i>Svadhya</i> (Self study)	Self study involves looking within oneself rather than externalizing or placing responsibility in external factors. For instance, if one is angry, he can do two things: he can either blame something or someone outside or can take the more challenging and often confronting approach, and look within himself to see what it is inside him that caused him to become angry. Thus, self study teaches how to resist the influence of any instance over the state of being. <sup>[10]</sup>
	<i>Ishvara Pranidhana</i> (Devotion to the Divine)	<i>Pra-</i> means fullness, <i>ni-</i> means under, and <i>dhana-</i> means placement i.e. <i>pranidhana</i> is surrendering of oneself to God and being devoted to the Divine. According to Patanjali, the eighth limb of yoga, known as <i>Samadhi</i> , comes to one who takes refuge in God. Through surrendering to God one is released from the bondages of earthly desires and is able to move beyond the senses into a more expanded state of consciousness. <sup>[10]</sup>
<i>Asanas - Posture</i>		Asanas are the physical positions or postures of yoga. Asana should be done with three qualities: steadiness, comfort, and a spirit of joy. Through the practice of asana one naturally comes to experience and be in harmony with infinity. Asanas purify the body and mind, when practiced with full awareness; leave you with a feeling of expansion and lightness. Each asana works to open channels of energy in the body and in so doing releases blockages and tension which are held in the physical, mental, and emotional bodies. There were originally over 8,000,000 asanas, most of which are named after animals. Observing how animals live in harmony with their environment and with their bodies, the <i>rishis</i> started to imitate them so that man could acquire this knowledge and also learn to live in harmony with themselves and the environment. There are two types of asanas: dynamic and static. Static asanas are those that are held for a period of time with no movement. The body remains as still as possible. These asanas have a powerful effect on the life force ( <i>prana</i> ) and mental bodies, gently massaging the internal organs, glands, and muscles and relaxing the nerves, bringing tranquility to the mind. Dynamic asanas, which are more energetic, speed up the circulation and loosen the muscles and joints, releasing energy blocks and removing stagnant blood from different parts of the body. <sup>[10]</sup>
<i>Pranayama - Breath Awareness</i>		<i>Pranayama is not, as many think, something about the breath; breath, indeed, has very little to do with it, if anything. Breathing is only one of the many exercises through which we get to the real Pranayama.</i> <sup>[1]</sup> <i>Prana</i> , a word often used in yoga, is the vital life-force of life. When the <i>prana</i> in the body is low, one tends to be more lethargic, dull, and unenthusiastic. Toxins then accumulate in these areas and pain, stiffness or disease set in. Through the practice of yoga, <i>prana</i> begins to flow, allowing toxins to be released and removed. On the other hand, the body is just a gross form of the mind. They are not the separate entities often one thinks of them as and every mental knot has a corresponding physical knot in the body and vice versa. The aim of yogic practices is to release these knots and to connect us with the joy, love, and creativity, integrating, and harmonizing the body and mind. Patanjali devoted five sutras out of 195 sutras, on breathing alone. This in itself shows what a valuable and important tool the breath is in yoga. As the practice of pranayama is very powerful, it is important that it is learned with proper guidance. A natural result of going deep into <i>pranayama</i> is clarity, steadiness and one-pointedness of the mind. <sup>[1]</sup>
	<i>Dirgha pranayama</i> or “yogic breath”	Also known as the three-part breath as it is done seated and involves taking a full breath in three separate inhalations, each with a short pause between them; the first deeply into the abdomen as far as the rib cage, the second into the rib cage expanding the ribs and finally all the way up to the chest and clavicles which actually lift slightly as the lungs fill with air. The exhale is also done in three parts but in the opposite direction, clavicles descending first, then the ribs and abdomen, again each with a short pause in between. This is a slow deep breath that utilizes all the alveoli in the lungs, flushing the entire lungs with fresh air and allowing for a greater percentage of oxygen to be in haes making O <sub>2</sub> and CO <sub>2</sub> exchange more efficient. <sup>[11]</sup>

(Continued)

Table 2: (Continued)

<i>Ujjayi pranayama</i>	The <i>ujjai</i> breath (“victorious breath”) is best known for its use throughout the asana practice in Asthanga yoga but it is a separate pranayama technique in itself involving the gently contraction and lifting of the <i>uddiyana bandha</i> and the <i>mula bandha</i> to lift the breath up into the thoracic cavity. It can be practiced with or without <i>kumbhakas</i> . It is also known as the ocean breath due to the sound made by the gentle engagement of the <i>jalandhara bandha</i> in the throat to create some resistance to the passage of air. This sound should become more subtle as the practitioner advances in both asana and pranayama so that it is audible to only the practitioner themselves. In the yoga sutras Patanjali suggests that the breath should be <i>dirga</i> (long) and <i>sukhma</i> (smooth). It is a balancing and calming breath which builds up internal heat and increases oxygenation. <sup>[11]</sup>
<i>Nadi shodhana</i>	This pranayama is also known as alternate nostril breathing as the thumb of the right hand is used to close the right nostril and the ring finger of the same hand is used to close the left nostril. One round consists of inhaling through one nostril for a defined length of time (varying from person-to-person) and exhaling through the same length of time the same side. This nostril is then closed and the same breath is repeated through the other nostril. In a controlled study it was shown that breathing through the right nostril resulted in a significant increase of 37% in baseline oxygen consumption, alternately breathing through both nostrils showed and 18% increase while breathing through the left nostril resulted in a 24% increase. The left nostril pranayama group showed an increase in galvanic skin resistance, the electrical resistance of the skin which is a measure of emotions in people that is part of the polygraph test. Fear, anger, startle response, sexual feelings are all among the emotions which may produce similar GSR responses. An increase is interpreted as a reduction in sympathetic nervous system activity. <sup>[12]</sup> These results suggest that breathing selectively through either nostril could have a marked activating effect or a relaxing effect on the sympathetic nervous system.
<i>Viloma pranayama</i>	<i>Viloma</i> means against the natural order of things. In <i>viloma pranayama</i> , inhalation or exhalation is done with several pauses. It teaches the practitioner how to fully utilize the entirety of the rib cage and how to direct the breath into specific areas of the chest ensuring a deep breath. <i>Viloma</i> can also be practiced through alternate nostrils and is called <i>anuloma viloma</i> . <i>Viloma</i> aerates the lungs and improves the muscle tone of the breathing muscles. Both <i>anuloma viloma</i> and <i>viloma</i> have been said to lower blood pressure, however the only controlled scientific study showed that there was an increase in systolic blood pressure probably due to cutaneous vasoconstriction as shown by the simultaneous decrease in digit pulse volume. <sup>[12]</sup> Both practices have also been shown to increase oxygen consumption and therefore may be of benefit to the obese that are known to have a lowered resting metabolic rate than the non obese called <i>anuloma viloma</i> . <i>Viloma</i> aerates the lungs and improves the muscle tone of the breathing muscles. Both <i>anuloma viloma</i> and <i>viloma</i> have been said to lower blood pressure, however the only controlled scientific study showed that there was an increase in systolic blood pressure probably due to cutaneous vasoconstriction as shown by the simultaneous decrease in digit pulse volume. <sup>[12]</sup>
<i>Sitali pranayama</i>	<i>Sitali</i> is also called tongue hissing due to the sound produced when practicing it. The tongue is curled up into a tube and during inhalation the air passes over the moist tongue, cooling down and refreshing the throat. The tongue is drawn back into the mouth and the lips are closed at the end of the inhalation and the exhalation takes place either through the throat or alternately through the nostrils. This is a cooling pranayama which is thought to have developed from observation of how animals breathe to cool down using their tongues.
<i>Kapalabhati</i>	<i>Kapalabhati</i> means skull shining breath and is one of the cleansing techniques of yoga. If there is mucus in the air passages or tension and blockages in the chest it is often helpful to breathe quickly. In this practice the diaphragm and associated muscles are used to “pump” the air rapidly out of the lungs in a forced exhalation. This is followed by a rapid but passive inhalation. “ <i>Bhati</i> ” means “that which brings lightness.” One must be careful with this technique because there is a danger of creating great tension with the breath or one

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**Table 2:** (Continued)

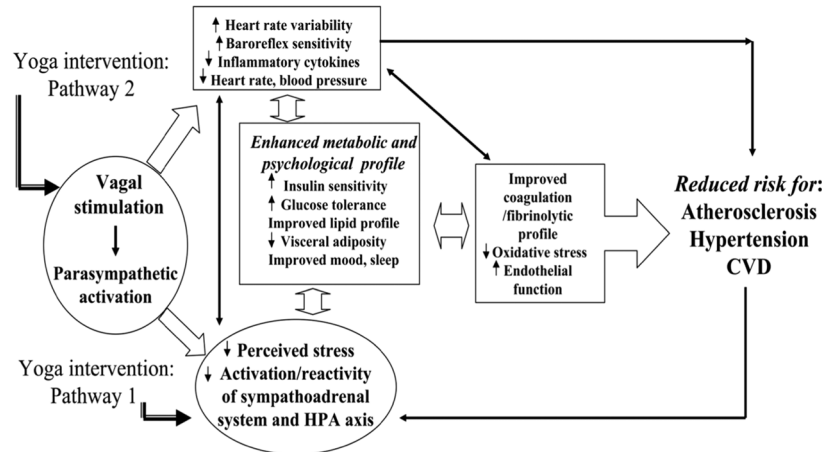
	may become quite dizzy when breathing becomes rapid. For this reason kapalabhati is usually concluded with some deep slow breaths. One study showed that kapalabhati modifies the autonomic status by increasing sympathetic activity (“fight-or-flight”) with reduced vagal activity (Vagus nerve innervates the lungs and stomach, increases heart rate and blood pressure). <sup>[13]</sup>
<i>Pratyahara - Sense withdrawal</i>	The word <i>ahara</i> means “nourishment”; <i>pratyahara</i> translates as “to withdraw oneself from that which nourishes the senses.” By quieting the senses and taking the mind inwards one can unite with the Self. Pratyahara means drawing back or retreat. In yoga, the term pratyahara implies withdrawal of the senses from attachment to external objects. It can then be seen as the practice of non-attachment to sensory distractions as one constantly returns to the path of self realization and achievement of internal peace.
<i>Dharana - Concentration and cultivating inner perceptual awareness</i>	<i>Dharma</i> means “immovable concentration of the mind.” The essential idea is to hold the concentration or focus of attention in one direction. When the body has been tempered by asanas, when the mind has been refined by the fire of pranayama and when the senses have been brought under control by pratyahara, the <i>sadhaka</i> (seeker) reaches the sixth stage, <i>dharana</i> . Here he is concentrated wholly on a single point or on a task in which he is completely engrossed. The mind has to be stilled in order to achieve this state of complete absorption. <sup>[10]</sup>
<i>Dynana - Meditation</i>	<i>Dynana</i> or meditation is all about just “being.” Meditation takes us back to that space of “being” from where deep rest can be experienced and enormous energy and vitality gained. Whilst effort is required to build the body, for example one has to work out either at the gym or by doing various exercises and sports; it is quite the opposite with the mind. The mind requires effortlessness in order to meditate. The less effort that is applied in meditation, the deeper the meditation will be. To truly understand meditation it has to be experienced personally and like anything, the benefits can only be experienced through dedicated practice and self-discipline.
<i>Samadhi - Contemplation</i>	According to Patanjali, “losing consciousness of the body, breath, mind, intelligence, and ego” and residing in a state of peace and bliss in which wisdom, humility and simplicity shine through, one is in a state of samadhi. Enlightened beings, which are permanently in a state of samadhi, have the ability to illuminate all those who come to him in their search for truth.

pathway, yoga has been shown to have immediate psychological effects: decreasing anxiety<sup>[16,17,25,26]</sup> and increasing feelings of emotional, social, and spiritual well-being.<sup>[27]</sup> Several literature reviews have been conducted that examined the impact of yoga on specific health conditions including cardiovascular disease<sup>[28]</sup> metabolic syndrome,<sup>[23]</sup> diabetes,<sup>[29]</sup> cancer,<sup>[30]</sup> and anxiety.<sup>[14]</sup> Galantino *et al.*<sup>[31]</sup> published a systematic review of the effects of yoga on children. These reviews have contributed to the large body of research evidence attesting to the positive health benefits of yoga. The purpose of this article is to present a comprehensive review of the literature regarding the impact of yoga on a variety of health outcomes and conditions.

### Hypertension

It is well known that many antihypertensive agents have been associated with numerous undesirable side effects. In addition to medication, moderately intense aerobic exercise is well known to lower blood pressure. Interestingly, it

has been very convincingly demonstrated in a randomized controlled study that even a short period of regular yogic practice at 1 h/day is as effective as medical therapy in controlling blood pressure in hypertensive subjects.<sup>[32]</sup> Yoga, together with relaxation, biofeedback, transcendental meditation, and psychotherapy, has been found to have a convincing antihypertensive effect.<sup>[33]</sup> The mechanism of yoga-induced blood pressure reduction may be attributed to its beneficial effects on the autonomic neurological function [Figure 1]. Impaired baroreflex sensitivity has been increasingly postulated to be one of the major causative factors of essential hypertension.<sup>[20]</sup> The practice of yogic postures has been shown to restore baroreflex sensitivity. Yogic asanas that are equivalent to head-up or head-down tilt were discovered to be particularly beneficial in this regard. Tests proved a progressive attenuation of sympatho-adrenal and renin–angiotensin activity with yogic practice. Yogic practice, through the restoration of baroreceptor sensitivity, caused a significant reduction in the



**Figure 1:** Hypothesized pathways by which yoga intervention may enhance cardiovascular risk profile

blood pressure of patients who participated in yoga exercise.<sup>[20,34]</sup> Yoga has proven efficacy in managing secondary cardiac complications due to chronic hypertension. Left ventricular hypertrophy secondary to chronic hypertension is a harbinger of many chronic cardiac complications, such as myocardial ischemia, congestive cardiac failure, and impairment of diastolic function. Cardiovascular response to head-down-body-up postural exercise (*Sarvangasana*) has been shown to be particularly beneficial in preventing and treating hypertension-associated left ventricular hypertrophy and diastolic dysfunction. In one study, the practice of *sarvangasana* for 2 weeks caused resting heart rate and left ventricular end diastolic volume to reduce significantly. In addition, there was mild regression of left ventricular mass as recorded in echocardiography.<sup>[35]</sup>

### Coronary atherosclerosis

In a randomized controlled study, patients with angiographically proven coronary artery disease who practiced yoga exercise for a period of 1 year showed a decrease in the number of anginal episodes per week, improved exercise capacity and decrease in body weight. Serum cholesterol levels (total cholesterol, LDL cholesterol and triglyceride levels) also showed greater reductions as compared with control groups. It is evident in recent studies that yoga can control LDL cholesterol<sup>[36]</sup> and hypertension.<sup>[33]</sup> Revascularization procedures were required less frequently in the yoga group. Follow-up angiography at 1 year showed that significantly more lesions regressed in the yoga

group compared with the control group. Thus, yoga exercise increases regression and retards progression of atherosclerosis in patients with severe coronary artery disease.<sup>[37]</sup> However, the mechanism of this effect of yoga on the atherosclerotic plaque remains to be studied. Lipid lowering and plaque-stabilizing effects of yoga exercise seem to be similar to that of statin drugs (HMG CoA reductase inhibitors). It is important to carry out biochemical and immunological studies among practitioners of yoga to see whether it has similar mechanisms of action to statins that have favorable effects on atherosclerosis and vascular properties other than those attributed to cholesterol lowering. Statin activity is associated with the increased production of nitric oxide in the vascular endothelium, which has local vasodilator properties in addition to anti-atherogenic, antiproliferative, and leukocyte adhesion-inhibiting effects. It is also known to enhance endothelium-dependent relaxation, inhibit platelet function, and inhibit the activity of endothelin-1, a potent vasoconstrictor and mitogen. Statins also reduce inflammatory cytokines.<sup>[38]</sup> There may be some parallels between the pharmaco-physiological effects of statin therapy and the changes brought about by the practice of yoga in the internal milieu. This change in the internal milieu triggered by the practice of yoga may well be mediated by a neurohormonal mechanism.

### Serum lipid profile and body weight

Obesity and increased body weight are strong risk factors for ischemic heart disease and hypertension.



Yoga has been found to be particularly helpful in the management of obesity. A randomized controlled study revealed that practicing yoga for a year helped significant improvements in the ideal body weight and body density.<sup>[39]</sup> The regular practice of yoga has shown to improve the serum lipid profile in the patients with known ischemic heart disease as well as in healthy subjects.<sup>[36]</sup> The mechanism of the beneficial effect of yoga in the management of hyperlipidemia and obesity cannot be explained by simple excess caloric expenditure since the practice of asanas does not bring about increased, rapid large muscle activity and energy generation. However, the efficacy of yoga in the management of hyperlipidemia and obesity is of significance.

### Cardiorespiratory efficiency and physical fitness

Madanmohan *et al.*<sup>[40]</sup> have reported that yoga training of 6 weeks duration attenuates the sweating response to step test and produces a marked increase in respiratory pressures and endurance in 40 mmHg test in both male and female subjects. In another study, they reported that 12 weeks of yoga practice results in a significant increase in maximum expiratory pressure, maximum inspiratory pressure, breath holding time after expiration, breath holding time after inspiration, and hand grip strength.<sup>[41]</sup> Joshi *et al.*<sup>[42]</sup> have also demonstrated that 6 weeks of pranayama breathing course resulted in improved ventilatory functions in the form of lowered respiratory rate, and increases in the forced vital capacity, forced expiratory volume at the end of first second, maximum voluntary ventilation, peak expiratory flow rate, and prolongation of breath holding time. Similar beneficial effects were observed by Makwana *et al.*<sup>[43]</sup> after 10 weeks of yoga practice. An increase in inspiratory and expiratory pressures suggests that yoga training improves the strength of expiratory and as well as inspiratory muscles. Respiratory muscles are like skeletal muscles. Yogic techniques involve isometric contraction which is known to increase skeletal muscle strength. Breath holding time depends on initial lung volume. Greater lung volume decreases the frequency and amplitude of involuntary contractions of respiratory muscles, thereby lessening the discomfort of breath holding. During yoga practice, one consistently and

consciously over-rides the stimuli to respiratory centers, thus acquiring control over the respiration. This, along with improved cardio-respiratory performance, may explain the prolongation of breath holding time in yoga-trained subjects.

Yogic techniques are known to improve one's overall performance and work capacity.<sup>[44]</sup> Physical fitness not only refers cardiorespiratory fitness and muscular strength, but also coordination and flexibility i.e. the full range of physical qualities which can be understood as an integrated measurement of all functions and structures involved in the performance.<sup>[45-48]</sup> In adults, low physical fitness (mainly cardiorespiratory fitness) seems to be a stronger predictor of both cardiovascular and all-cause mortality than any other well-established risk factors.<sup>[49]</sup> Sharma *et al.*<sup>[50]</sup> conducted a prospective controlled study to explore the short-term impact of a comprehensive but brief lifestyle intervention based on yoga, on subjective well-being in normal and diseased subjects. Normal healthy individuals and subjects having hypertension, coronary artery disease, diabetes mellitus, or a variety of other illnesses were included in the study. They reported significant improvement in the subjective well-being scores of 77 subjects within a period of 10 days as compared to controls. Therefore, even a brief intervention can make an appreciable contribution to primary prevention as well as management of lifestyle diseases. Oken *et al.*<sup>[51]</sup> found that hatha yoga practices for 6 months by seniors (65–85 years) resulted in significant improvement in quality of life and physical measures compared to walking exercise and wait-list control groups.

### Diabetes mellitus

Yoga has been shown to be a simple and economical therapeutic modality that may be considered as a beneficial adjuvant for non insulin dependant diabetes mellitus (NIDDM) patients. In a group of diabetics who practiced yoga regularly, there was a significant reduction in the frequency of hyperglycemia and area index total under the oral glucose tolerance test curve. This experimental study showed that there was also a decrease in the need for oral hypoglycemic to maintain adequate blood sugar control in the population that practiced yoga.<sup>[52]</sup> Chaya *et al.*<sup>[53]</sup> reported a significant decrease in fasting plasma insulin in the yoga practitioners. They also found

that long-term yoga practice is associated with increased insulin sensitivity and attenuation of the negative relationship between body weight or waist circumference and insulin sensitivity. Manjunatha *et al.*<sup>[54]</sup> studied the effect of four sets of asanas in random order for 5 consecutive days and observed that the performance of asanas led to increased sensitivity of B cells of the pancreas to the glucose signal. They proposed that this increased sensitivity is likely to be a sustained change resulting from a progressive long-term effect of asanas. The mechanism of the anti-glycemic activity of yoga exercise has yet to be described. A mechanism of neurohormonal modulation involving insulin and glucagon activity remains a possibility.

### Neurohormonal activity

Increased intrinsic neurohormonal activity has been associated with increased predisposition to ischemic heart disease. This may explain how general stress in life contributes to increased risk of myocardial disease. Level of adverse neurohormonal activity can be quantitated by the measurement of specific markers in serum and urine. It has been described that regular practitioners of yoga asanas showed a significant reduction in the markers of intrinsic neurohormonal activity such as urinary excretion of catecholamines, aldosterone, as well as serum testosterone and luteinizing hormone levels. In an experimental study, they also showed an increase in the urinary excretion of cortisol.<sup>[20]</sup> Yoga-based guided relaxation helped in the reduction of sympathetic activity with a reduction in heart rate, skin conductance, oxygen consumption, and increase in breath volume – the clinical signs of neurohormonal activity, thus facilitating protection against ischemic heart disease and myocardial infarction.<sup>[55]</sup>

### Reproductive functions and pregnancy

Studies have shown that practice of yoga orchestrates fine tuning and modulates neuro-endocrine axis which results in beneficial changes in the practitioners. Schmidt *et al.*<sup>[34]</sup> found a reduction in urinary excretion of adrenaline, noradrenaline, dopamine, and aldosterone, a decrease in serum testosterone and luteinizing hormone levels and an increase in cortisol excretion, indicating optimal changes in hormones. Kamei *et al.*<sup>[56]</sup> found changes in brain waves

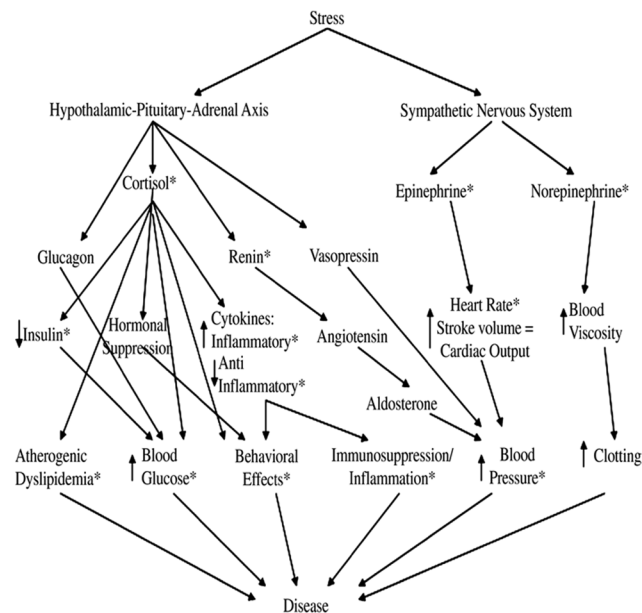
and blood levels of serum cortisol during yoga exercise in 7 yoga instructors and found that alpha waves increased and serum cortisol significantly decreased.

Narendran *et al.*<sup>[57]</sup> found that yoga practices including physical postures, breathing, and meditation practiced by pregnant women 1 h daily resulted in an increase in birth weight, decrease in preterm labor, and decrease in IUGR either in isolation or associated with PIH, with no increased complications. Beddoe *et al.*<sup>[58]</sup> found that women practicing yoga in their second trimester reported significant reductions in physical pain from baseline to post intervention. Women in their third trimester showed greater reductions in perceived stress and trait anxiety. From this, it is clear that yoga can be used to prevent or reduce obstetric complications.

### Stress and anxiety

Since the 1970s, meditation and other stress-reduction techniques have been studied as possible treatments for depression and anxiety. One such practice, yoga, has received less attention in the medical literature though it has become increasingly popular in recent decades. Available reviews of a wide range of yoga practices suggest they can reduce the impact of exaggerated stress responses and may be helpful for both anxiety and depression. It mainly acts via down-regulating the HPA axis that trigger as a response to a physical or psychological demand (stressor) [Figure 2], leading to a cascade of physiological, behavioral, and psychological effects, primarily as a result of the release of cortisol and catecholamines (epinephrine and norepinephrine).<sup>[59]</sup> This response leads to the mobilization of energy needed to combat the stressor through the classic “fight or flight” syndrome. Over time, the constant state of hypervigilance resulting from repeated firing of the HPA axis can lead to deregulation of the system and ultimately diseases such as obesity, diabetes, autoimmune disorders, depression, substance abuse, and cardiovascular disease.<sup>[60,61]</sup>

In this respect, yoga functions like other self-soothing techniques, such as meditation, relaxation, and exercise. By reducing perceived stress and anxiety, yoga appears to modulate stress response systems. This, in turn decreases physiological arousal e.g., reducing the heart rate,



**Figure 2:** The impact of stress on the hypothalamic-pituitary-adrenal (HPA) axis and the sympathetic nervous system. \*Yoga has been shown to have significant beneficial effects in these items

lowering blood pressure, and easing respiration. There is also evidence that yoga practices help increase heart rate variability, an indicator of the body's ability to respond to stress more flexibly. A small but intriguing study further characterizes the effect of yoga on the stress response. In 2008, researchers at the University of Utah showed that among control subjects and yoga practitioners, by functional MRIs, that yoga practitioner had the highest pain tolerance and lowest pain-related brain activity during the MRI. The study underscores the value of techniques, such as yoga, that can help a person regulate their stress and, therefore, pain responses.<sup>[62]</sup> Tooley *et al.*<sup>[63]</sup> found significantly higher plasma melatonin levels in experienced meditators in the period immediately following meditation compared with the same period at the same time on a control night. It was concluded that meditation can affect plasma melatonin levels. It remains to be determined whether this is achieved through decreased hepatic metabolism of the hormone or via a direct effect on pineal physiology. Either way, facilitation of higher physiological melatonin levels at appropriate times of day might be one avenue through which the claimed health promoting effects of meditation occur. In another study, Harinath *et al.*<sup>[64]</sup> evaluated the effects of

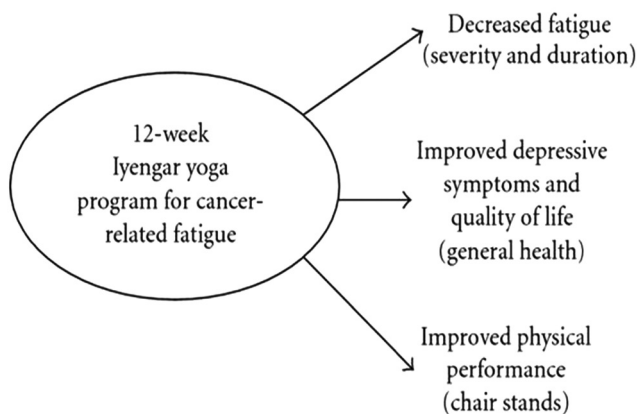
3 month hatha yoga practice and Omkar meditation on melatonin secretion in healthy subjects. Yoga group subjects practiced selected yogic asanas for 45 min and pranayama for 15 min during the morning, whereas during the evening hours these subjects performed preparatory yogic postures for 15 min, pranayama for 15 min, and meditation for 30 min daily for 3 months. Results showed that yoga practice for 3 months resulted in an improvement in cardiorespiratory performance and psychological profile. The plasma melatonin also showed an increase after 3 months of yogic practice. Also, the maximum night time melatonin levels in the yoga group showed a significant correlation with well-being score. These observations suggest that yogic practices can be used as psychophysiological stimuli to increase endogenous secretion of melatonin, which, in turn, might be responsible for improved sense of well-being. In some other studies, it has been found that subjects trained in yoga can achieve a state of deep psychosomatic relaxation associated with highly significant decrease in oxygen consumption within 5 min of practicing *savitri pranayama* (a slow, rhythmic and deep breathing) and *shavasana*.<sup>[65]</sup>

### Mood and functioning

In a German study published in 2005, women who described themselves as “emotionally distressed” are treated with 90-min yoga classes a week for 3 months. At the end of 3 months, women in the yoga group reported improvements in perceived stress, depression, anxiety, energy, fatigue, and well-being. Depression scores improved by 50%, anxiety scores 30%, and overall well-being scores by 65%. Initial complaints of headaches, back pain, and poor sleep quality also resolved much more often in the yoga group than in the control group. Another 2005 study examined the effects of a single yoga class for inpatients at the New Hampshire psychiatric hospital, 113 participants among patients with bipolar disorder, major depression, and schizophrenia it is found after yoga class, tension, anxiety, depression, anger, hostility, and fatigue dropped significantly. Further controlled trials of yoga practice have demonstrated improvements in mood and quality of life for elderly, people caring for patients with dementia, breast cancer survivors, and patients with epilepsy.<sup>[66]</sup>

## Cancer

Earlier reviews have reported that yoga is beneficial for people with cancer in managing symptoms such as fatigue, insomnia, mood disturbances and stress, and improving quality of life.<sup>[67]</sup> However, until now the size of the effect has not been quantified. But in some studies, it is found that yoga may have positive effects on psychological health of cancer patients [Figure 3]. Many cancer patients experience cancer-related psychological symptoms, including mood disturbances, stress, and distress.<sup>[67]</sup> Ledesma and Kumano<sup>[68]</sup> showed mindfulness-based stress reduction programs may indeed be helpful for the mental health of cancer patients. Thus, yoga may have long-term psychological effects for patients with cancer. According to the some review,<sup>[30]</sup> no significant differences were observed on the measure of physical health. Because of the limited number of studies and different measurement tools, the effects of yoga on physical health in people with cancer remain unclear. Only one study<sup>[69]</sup> examined the effects of yoga on physical fitness; therefore, future study could include outcome measures that not only include subjective feelings in questionnaires but also include physical performance, physical strength, endurance, and flexibility. All studies included in the meta-analysis investigated participants with a diagnosis of cancer; however, the types of cancer varied among studies. Of the 10 included studies, 7 investigated breast cancer, 2 recruited mixed cancer populations, and 1 included patients with lymphoma. The result of Cohen's study on lymphoma<sup>[70]</sup> showed no significant differences between groups in terms of anxiety, depression,



**Figure 3:** Demonstrates positive outcomes of Yoga program for cancer-related fatigue in breast cancer survivors

distress, or fatigue; thus, it has little influence on our result. Therefore, since the majority of studies focused on breast cancer, future research needs to examine the use of yoga among male cancer patients and female non-breast cancer patients. In addition, various factors are associated with the execution of the intervention such as yoga styles and treatment doses that may influence effect size. Four different styles of yoga were used among the included studies: restorative, integrated, hatha, and Tibetan. Treatment dose, including duration and frequency, and the adherence to yoga intervention and home practice may also affect treatment outcome. According to the Carson's study of yoga for women with metastatic breast cancer,<sup>[71]</sup> patients who practiced yoga longer on a given day were much more likely to experience less pain and fatigue and greater invigoration, acceptance, and relaxation on the next day. In summary, most of the studies show potential benefits of yoga for people with cancer in improvements in psychological health. But, more attention must be paid to the physical effects of yoga and the methodological quality of future research, as well as to improve these areas in the future.

## RISKS OF YOGA PRACTICE

Although many forms of yoga practice are safe, some are strenuous and may not be appropriate for everyone. In particular, elderly patients or those with mobility problems may want to check first with a clinician before choosing yoga as a treatment option. Only one incident has been reported in the surveyed medical literature associated with the risks due to the practice of yoga. The serious case that has been reported is of a female practitioner developing thrombosis of vertebrobasilar artery due to an intimal tear and subsequent stroke. This was attributed to adopting an unusual neck posture during yoga practice.<sup>[72]</sup> Yoga, although not entirely risk-free, can be considered a safe form of exercise if practiced under the guidance and supervision of a qualified trainer. But for many patients dealing with depression, anxiety, or stress, yoga may be a very appealing way to better manage symptoms. Indeed, the scientific study of yoga demonstrates that mental and physical heal are not just closely allied, but is essentially equivalent. The evidence is growing that yoga practice is a relatively low-risk, high-yield approach to improving overall health.

## CONCLUSION

In summary, this review postulates that mind–body exercise such as yoga couples sustained muscular activity with internally directed focus, producing a temporary self-contemplative mental state. It also triggers neurohormonal mechanisms that bring about health benefits, evidenced by the suppression of sympathetic activity. Thus, it reduces stress and anxiety, improves autonomic and higher neural center functioning and even, as shown in some studies, improves physical health of cancer patients. However, there is a definite need for more directed scientific work to be carried out to elucidate the effects and the mechanisms of such effects of yoga on the human body in health and disease. Considering the scientific evidence discussed thus far, it is fair to conclude that yoga can be beneficial in the prevention and cure of diseases.

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