



# Yoga For Stress Alleviation: A Psychophysiological Perspective



Debajyoti Mukherjee<sup>1</sup>, Tamal Das<sup>2</sup> and Amit Bandyopadhyay<sup>1\*</sup>

<sup>1</sup>Sports and Exercise Physiology Laboratory, Department of Physiology, University of Calcutta, University Colleges of Science and Technology, 92 A.P.C. Road, Kolkata, West Bengal, India

<sup>2</sup>Department of Physiology, Vidyasagar Metropolitan College, 8A Shib Narayan Das Lane, Kolkata, West Bengal, India

Submission: March 12, 2023; Published: March 23, 2023

\*Corresponding author: Amit Bandyopadhyay, Sports and Exercise Physiology Laboratory, Department of Physiology, University of Calcutta, University Colleges of Science and Technology, 92 A.P.C. Road, Kolkata, West Bengal, India

## Abstract

Yoga contemporarily, is believed to have a multifaceted impact on inducing declinations of all round stress levels. Amidst elevated stress-stricken lifestyles, it is now accepted widely as an alternative to medicine therapy. Aside uniting the mind, body and the soul, a major impetus of yoga is also the alleviation of stress, which it pivots, at various stratum, one of which is the psychophysiological one. Although, the number of research works that have been conducted in the psychophysiological domain is limited, there is a high scope of exploration of the aspects of yoga in improving the psychophysiological status of individuals. Techniques such as yoga postures, regulated breathing, relaxation, and meditation have been increasingly investigated in mainstream science. Regarding the psychological and physiological contexts of yoga, clinical implications and benefits have been noted in three phases- during, immediately after or some time following its practices. Psychophysiology is basically the branch of psychology mainly concerned with the physiological bases of psychological processes and the regulating mechanisms behind them. The review mainly aims to interpret the role of yoga in eradication and minimization of stress levels from the several contexts of psychophysiology. It also depicts the perceptions of yoga from the times of its inception, the perception today, as viewed from global standpoints and ultimately an elucidation of its profoundness in providing better lifestyle approaches.

**Keywords:** Alleviation; Health; Physiology; Psychology; Psychophysiology; Stress; Yoga

**Abbreviations:** MBSR: Mindfulness Based Stress Reduction; MBCT: Mindfulness Based Cognitive Therapy; TM: Transcendental Meditation; EEG: Electroencephalography; HR: Heart Rate; SCL: Skin Conductance Level; BVP: Blood Volume Pulse; HRV: Heart Rate Variability; MS: Metabolic Syndrome; MAST: Mental Arithmetic Stress Test; BFI: Brief Fatigue Inventory; HADS: Hospital Anxiety and Depression Scale; PSQI: Pittsburgh Sleep Quality Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; RR: Respiratory Rate; PR: Pulse Rate; PRMDs: Performance Related Musculoskeletal Disorders; VCS: Visual Contrast Sensitivity; AEP: Auditory Evoked Potentials; BAEP: Brainstem Auditory Evoked Potentials; MLR: Mid Latency Responses; RNYB: Right Nostril Yoga Breathing; LNYB: Left Nostril Yoga Breathing; ANYB: Alternate Nostril Yoga Breathing; EI: Emotional Intelligence; VC: Vital Capacity; FVC: Forced Vital Capacity; ALT: Alanine Aminotransferase; AST: Aspartate Amino Transferase

## Introduction

Yoga is an original and ancient holistic art of living which incorporates physical, mental, moral, and spiritual spheres of human existence. The Sanskrit word, yoga means “union” or “to join” and the practice of yoga brings this union to all levels of oneself. In general, yoga is thought to lay stress primarily on exercises that induce physical health benefits, and on many occasions, yogasanas are conducted on a regular basis on participants of stretching classes. The past two decades, have witnessed yoga as an increasingly accepted practice. Recommendations from physicians, psychotherapists, chiropractors, nurses have also helped yoga to capture the spotlight as an effective remediation for combating stress.

Increasing the practices of yoga is thought to induce elevations in one’s holistic and transforming qualities [1].

In recent years the word Yoga has found its place in the Anglo-Saxon vocabulary. To it many repellent and strange connotations have somehow become associated, even though the definition in the dictionary is substantially correct that refers yoga as “Hindu system of philosophical meditation and asceticism designed to affect the reunion of the devotee’s soul with the universal spirit.” A general reason for misapprehension today is that the dictionary definition involves assumptions that oppose the present-day thoughts, mainly the existence of such a thing as “soul” or “universal spirit”. Another reason of this

major misapprehension is that the word Yoga is associated with a class of emaciated and unclean fanatics given to self-torment sometimes encountered in India by tourists and described in books of travel. A third reason could be the introduction derived from the fact that here in the West, the teaching of “Yoga practices” by unscrupulous or unqualified persons has wrought an incalculable amount of secret harm [2].

### Discussion

The effects of yoga in alleviation of stress, anxiety and depression have been extensively studied over the past few years by medical students, nursing students and students of allied fields. Regular implementation of yoga postures and asanas largely seem to influence various psychological and physiological parameters of the body. It also reduces the levels of perceived anxiety and depression and helps in the cultivation of positive empathy, emotions and compassion. Yoga, when adopted and integrated into regular school or college curricula and professional workplaces significantly enhances the productivity and skills of students or employers at workplace. Today affordability and scarcity of facilities have indeed inculcated in physicians, the choice of selecting some alternate to medicine therapy particularly for patients at high-stake or susceptible to co-morbidity risk factors. This has enhanced the vogue of yoga exponentially over the last few years. Therefore, the number of research being conducted is much higher today. However, the role of yoga in psychological regulation, regulation of the physiological systems and in inducing holistic health benefits, makes it multidimensional. The present review article will delve into the origin of yoga, yoga as interpreted from different contexts and ultimately address the effects of yoga from the psychophysiological perspectives.

### Origin of Yoga: Indian Context

Yoga is a discipline constituted of several diverse practices that aims to better the status of mental and physical health, inner harmony, and holistic wellbeing and ultimately a science of union of the human with the universal and transcendent existence. The practice of yoga is said to have its inception from the times of early civilization in the Indian subcontinent and have been in a state of consistence since then in India and throughout East Asia. The limited applications of yoga are comparatively later in contrary to the Vedic origins of yoga. The first systematic approaches of therapeutic application started in India in 1918 at the yoga institute of Versova near Mumbai, the principle institute of the Yoga at Santa Cruz. This was later followed by the clinical work at the Kaivalyadhama. The Yoga Institute in Lonavala under Swami Kuvalyananda in the 1920s. Subsequently, the concept of yoga therapy dispersed in India with the development of yoga hospitals and yoga clinics, of which one major is the Swami Vivekananda Yoga Research Institute situated near Bangalore.

Research works conducted on the psychophysiological impacts of yoga also started with Kuvalyananda's work as the

foundation in the early 1920s and there are still large number of literature reviews which have been published based on the basic research literature. Furthermore, several research articles have been published in yoga specialized journals such as Yoga Mimamsa, which cannot be accessed easily hence are consistently cited or reviewed [3]. From this point of orientation current interpretations of yoga were explored and it was also considered how practitioners of yogic medicine and fitness combine the physiology, idea of biology and anatomy with those of transcendence, metaphysics, and magical power [4]. Yoga is said to be as old as human race on earth, yet there is no physical evidence in favor of this notion. But in the ruins and remnants of the cities of Mohenjo Daro and Harappa, excavators found depictions which are engraved on soapstone seals that strongly resemble yogi-like figures.

These figures prove that yoga originated in India for 5,000 or more years ago. After its genesis, yoga has been conferred through different periods from the Vedic period to modern era through Pre-classical Yoga period, Classical period, Postclassical Yoga period. During these stages, Yoga went through many phases which helped it to develop more and more in terms of its admiration. Earlier, yoga was confined to the yogis only but in the modern era it is for all. The science of Yoga comprises of old theories, observations & principles about the body, mind and soul which strive for their unification. Modern scientists inferred that it can be effectively transfigured into therapy which could heal the body. It makes the body more flexible and helps one to stay content amidst stress-stricken environment. This is one of the foremost reasons that why people want to adopt yoga to their lifestyles- to be more energetic, feel fitter, and full of relish [5].

### Factors Stretching Stress: Ameliorating Role of Yoga

Increased stress, depression and anxiety are common adaptations of modern-day lifestyle [6]. Due to the side effects displayed by various drugs prescribed for the treatment of anxiety and depression, and their lack of efficiency, researchers opt for some non-pharmacological and non-invasive treatments for these disorders [7]. Yoga exercises improve the various parameters of self-description, psychological status, and the quality of life [8]. Research recommends yoga as an effective mode of intellectual and mental exercise, aiding in improving health feeling [9]. Furthermore, yoga also improvises the psychological conditions essential for monitoring and fighting stress and negative emotions, increase positive emotions, and promotes mental parity [10]. Despite high popularity of yoga and the positive psychological and physiological effects induced by it, yet it is to be studied that to what extent it really impedes and treats mental disorders [11].

The potential stressors of modern work-life, increase the need of effective coping strategies that are accessible and affordable to the public. Yoga has been found to reduce the levels of stress in clinical samples, but studies are needed to

investigate effectiveness of standard gym yoga classes among functional individuals. Ninety individuals reporting moderate-to-high stress were randomly assigned and were made to perform 16 consecutive weeks of yoga, and a control group who did not practice yoga for 8 weeks, were then made to practice yoga for 8 weeks. Psychological health variables and stress variables were assessed at baseline, after 8 weeks, and after 16 weeks respectively. Significant reductions in stress and all psychological health measures were found within the yoga group post-administration after 16 weeks. When compared to the control group, yoga practitioners showed significant decrease in stress, anxiety, and general psychological health, and therefore displayed significant increase in holistic health.

The group who did not practice yoga showed significant decrease in stress, anxiety, depression, and insomnia after they practiced yoga for 8 weeks. Thus, it was concluded that Gym yoga appears to be effective for stress amelioration and promotion of psychological well-being among workers experiencing stress [12]. It is important to tackle poor mental health early since unattended symptoms can manifest to poorer clinical outcomes which include increased risk of developing a clinical diagnosis or relapse [13]. University students in distress, also seek for or receive some forms of treatment [14]. This is due to several barriers such as lack of awareness and stigma of services [14]. Mindfulness, meditation, and yoga have been depicted as a non-stigmatizing alternative to traditional mental health support.

They are highly popular tools at tertiary education institutes and are today effectively used for stress reduction and for improving productivity and mental health in general [15]. Yoga, meditation, and mindfulness are parts of a common suite of interventions called mind-body interventions [16]. MBSR (Mindfulness Based Stress Reduction) which includes a set of specific mindfulness practices primarily intended on focused attention on the breath, "body-scanning," prosocial meditations (e.g., loving kindness and compassion), and gentle hatha yoga. MBSR is different from Mindfulness- Based Cognitive Therapy (MBCT) as it includes cognitive therapeutic elements such as cognitive restructuring and is aimed at reducing depressive relapse [17].

### Psychology behind Incorporating Yoga in Daily Life

Majority of the research works conducted earlier on yoga were from the perspective of modern psychology in distinct contexts. It was initially investigated as a technique of gaining mastery over what was considered as autonomic nervous system or 'involuntary nervous system'. Alyce and Elmer Green of Yoga Federation of Serbia: Yoga – the Light of Micro-universe 42 Menninger Foundation seemed to be much influenced by the potentialities of yoga, which they studied in India and observed that biofeedback technique possess resemblance with certain procedures in the system of Yoga developed by Patanjali. The Biofeedback technique, since then, has been termed as Western

equivalent of Yoga by some. There are growing evidences that state that by using biofeedback techniques it is possible to regulate autonomic nervous system activity, which was previously considered to be beyond the voluntary control of humans.

The experiments which were conducted on the great yogi Swami Rama in Menninger Foundation in this direction (Science Studies Yoga by Swami Rama and Rudolph Balentine) also inculcated much research interest in the yoga potentials which led to the establishment of The Himalayan Institute for the scientific study of yoga in the United States. Moreover, the studies conducted on the self-stimulation of certain brain centers by rats, also later termed as "pleasure center", made researchers think whether there is a possibility that an organism could give up even basic needs if it manifested to get "pleasure", which, in origin is not extrinsic. This work which was conducted in the context of interpreting the brain-behavior relationship also made some scientists wonder whether yoga practices have similar effects in humans on the brain and nervous system. The research on Transcendental Meditation (TM) of Maharshi Mahesh Yogi in Harvard University also instilled widespread interest on its potentialities to induce relaxation. A term "relaxation response" was also coined to elucidate the diverse psychological and physiological changes that were recorded in a study on TM practitioners. The study unveiled many vistas of clinical application of meditative practices.

Researchers enthusiastic about the study of consciousness, also approached yoga procedures as a mode of inducing altered states of consciousness. It was also believed that meditation research has progressed in two primary directions viz., as a "self-regulation strategy" and as an "altered states of consciousness" [18]. Almost every person has episodes of anxiety, depression or psychotic dissociation ranging from one degree to another. A yoga therapist needs to investigate the mental health problems on a single spectrum, to place them in the context of one's life events and approach them holistically. Understanding the neurocognitive mechanisms underlying psychiatric symptoms and tracing the effects of yoga in terms of cognitive and affective processes is also very important. This knowledge may help to strive for an optimal approach for a yoga therapy treatment [19].

Yoga by origin, is a native Indian psycho-spiritual craft, implemented extensively for personal transformation and to alleviate and eradicate suffering in the human condition. In a way, yoga is a pan Indian concept since it is not restricted to any religion or sect, region or location. While it has its core in Brahmanism, Buddhists as well as Jainas have also practised some forms of yoga. "Yoga constitutes a characteristic dimension of Indian Thought," concludes Mircea Eliade [1969] in his book *Yoga: Immortality and Freedom*, "to such a point that wherever Indian culture and religion have paved their way, a more or less pure form of yoga can be found". There are formal reasons to

conceptualize yoga as a pre-Aryan native Indian practice(s) that was later incorporated into the Vedic tradition [20]. References to yoga practices head back to early Upanisadic times. Explicit mention of yoga has also been there in Maitrīdyant, Svetāsvatara and Katha Upanisads among others. Yoga has now acquired pan human relevance extending beyond the Indian community. Today, it is a billion-dollar business in the United States of America. Etymologically, the word “yoga” is derived from the root “yuj/,” which means “to bind” or “to yoke”. Yet there is an ambivalence as to what precisely are the things that yoga unifies or bind, although a wide variety of forms of yoga came into existence. Many of these are unorganized and some are mystical and esoteric. However, from the practices, three levels of binding can be discerned. The first level is connecting the mind and the body. The second level involves the unification of the mind and consciousness, which are considered distinct to the Indian tradition. The third level aims at uniting the manifested (individual) consciousness of the person with consciousness-as-such in general. In inclusion to the sense of “yoke” and “conjunction”, derived from the yuj-U, yoga has been derived from the stem yuji-a and it simply means concentration and samadhi [21].

### Impact of Yoga on Physiological Systems

Yoga in terms of physiological aspects, is a psycho-somatic-spiritual discipline striving for unity and harmony of our mind, body, and soul and a tool implemented for bringing about the ultimate unification of universal consciousness with individual consciousness [22]. The word ‘Pranayama’ has been derived from two Sanskrit words, namely, ‘prana’, which means vital force or life energy, ‘ayama’ which means to prolong [23].

When a person practices yoga, imparting within him/her, the yogic attitude (attitude of patience, persistent practice, overcoming obstacles within self, that is, trouncing laziness, anger, delusion, and desire for being different or better than others), there are several changes being induced in his/ her physiology [23].

Rejuvenation of pancreatic cells due to abdominal stretching during yoga, increase the utilization and metabolism of glucose in peripheral tissues, liver, and adipose tissues through enzymatic process [24].

Relaxing practices following active ones lead to more intense relaxation than relaxing practices alone, as documented by research from Swami Vivekananda yoga research foundation near Bangalore city and probability of neuroplasticity bringing about changes in the hypo-pituitary–pancreatic axis [25]. Developed and improved blood supply to the muscles, muscular relaxation, might enhance insulin receptor expression on muscles causing elevated glucose uptake by muscles and inducing declinations in blood sugar levels [26]. The improvement in the lipid levels post yoga interventions could be due to increased hepatic lipase and lipoprotein lipase at cellular level, which impact the lipoprotein

metabolism thereby ascending the uptake of triglycerides by adipose tissues [27,28].

### Yoga and Endocrine Regulation

Yoga postures can improvise the sensitivity of the beta cells of the pancreas to the glucose signal and improve the insulin sensitivity which, in turn, can be due to the concomitant effects of performing the postures [29]. Postures can directly affect the pancreas which can rejuvenate its capacity to produce insulin [30]. Moreover, regeneration of the pancreatic beta cells could occur by performing yoga exercises that promote blood circulation in the pancreatic region and yogasanas that stimulate the meridian of pancreas that assist some diabetic patients [31].

### Yoga and Autonomic Nervous System (ANS)

Practices of pranayama cause distension of the lung tissues thereby producing inhibitory signals from action of hyperpolarizing currents and slowly adapting receptors. These inhibitory signals originate from the cardiorespiratory region involving vagi thereby synchronizing the neural elements in the brain leading to changes in the autonomic nervous system; and a resultant condition characterized by reduced metabolism and dominance of the parasympathetic system [32]. Pranayama also modify various inflatory and deflatory lung reflexes and induce interactions with central neural element to bring about homeostasis in the body [33]. Transcendental Meditation (TM) influence the modifying activity of ascending reticular activating system and interact with autonomic centers in the brainstem thus affecting metabolic and cardiorespiratory parameters [33]. Increased melatonin levels could be one possible mechanism through which the claimed health promoting effects of meditation take place [34].

### Psychological and Physiological Contexts of Yoga: An Encapsulation

Yoga has been a subject of increasing interest within the scientific community and there are growing evidences that implementation of yoga-based interventions can lead to considerable changes in terms of physiological parameters, perceived emotional states and cognitive functioning. The practice of yoga is multivariant in nature, and typically involves a combination of postures or movement sequences, conscious breath regulation, relaxation techniques and the cultivation of sustained attentional focus that can manifest to meditative states. In inclusion to this, for some people, the aim of the practice is to experience a transcendent and unitive state of consciousness that ensures deep connection to meaning and purpose in life [35]. Yoga had its inception within the history of Hinduism in India and since its inception it developed as it started to spread across Asia and later into North America and Europe. Originally yoga was thought to be a comprehensive system for spiritual and personal awareness and discipline, integral to the Indian culture and to

its spiritual heritage, but today yoga is effectively implemented for physical fitness, weight management, and general wellness and increasingly acquired for its well-documented therapeutic effects for medical and emotional problems [36].

In the recent years, yoga, has increased its admirations specifically in the Western cultures as a major mode of exercise and fitness training regime. However, based on evidence put forward by an April 2001 Time magazine cover story on "The Power of Yoga", yoga still tends to remain trendy. The science of yoga should be better recognized by the health care community as an adjunct to conventional medical care today in the modern world where the stress levels have been elevating on logarithmic scales. Over the last decade, several researches that have been conducted, focused more on the applications of Hatha yoga which can be extensively implicated in improving the parameters of agility, flexibility etc. and can be effectively manipulated to stimulate the major physiological variables such as blood pressure, respiration and heart rate, and metabolic rate to improve the all-round exercise capacities [37].

A study investigated changes in the psychophysiological parameters induced by yoga and relaxation in response to stress levels of examination in 75 medical students. The study was conducted initially with recordings obtained from the subjects, of the five essential parameters in two segments- one before a month from the examination and second on the day of examination. The parameters comprised of anxiety level, heart rate, blood pressure, galvanic skin resistance and choice reaction time respectively. Individuals recruited for the study were assigned into three groups, each comprising of 25 members. One performed yoga and the other performed relaxation for a tenure of three months. The third group catered as the control of the study. Post- intervention recordings of the intermittent parameters revealed that significant improvements in choice reaction time were observed in the two groups that underwent yoga and relaxation. The control group displayed no changes [38].

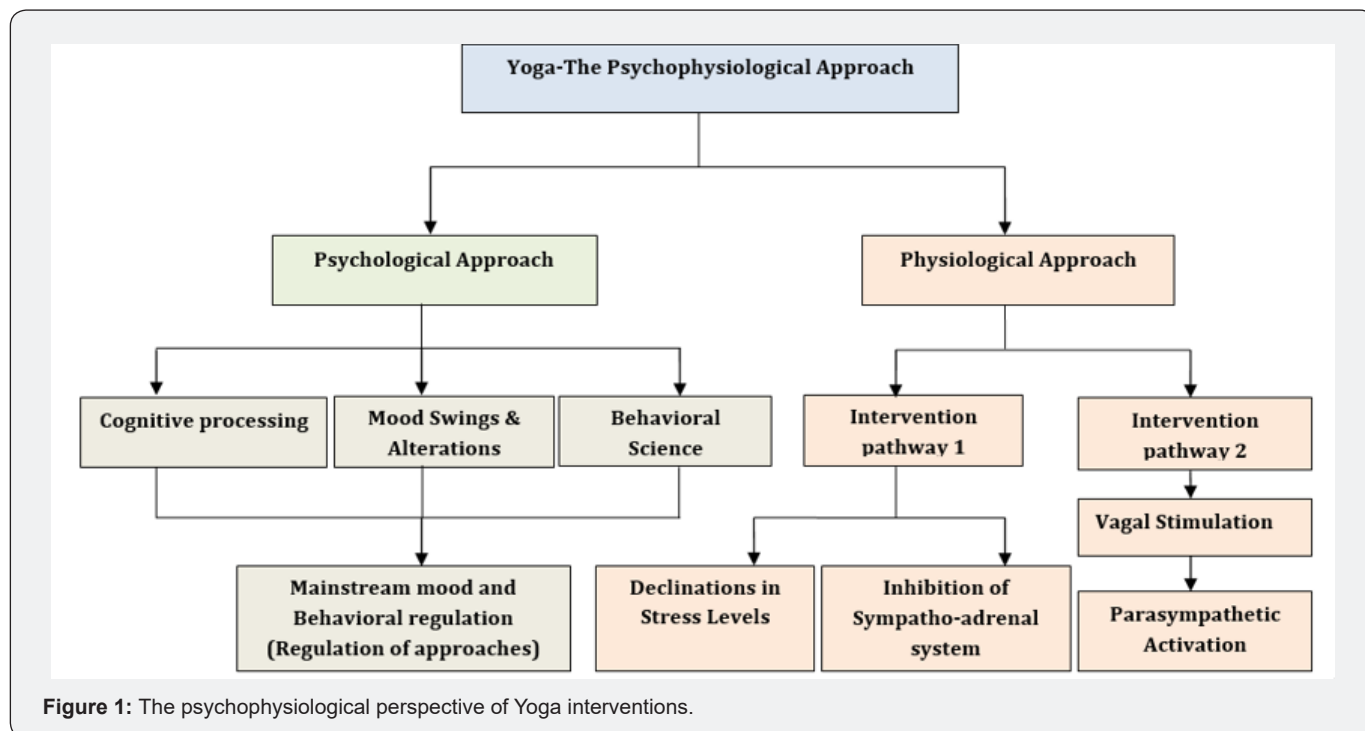
A similar study also investigated the role of Yoga in minimizing the all-round stress levels in college students. Vulnerability of the college students to stress is a major yet common circumstance which consist of critical phases in developmental maturation, rigorous facing of academic work, and being abstained from independent activity. The college students have significantly lower levels of physical activities. However, activities like bicycling, running etc. on a regular basis modulate their mood levels on a positive note. Yoga is an ancient mind-body technique which is thought to regulate mood and stress. The study was able to infer that yoga has positive effects on a psychophysiological level by reducing the stress levels in the college students [39].

Autonomic and electroencephalographic (EEG) correlates of Tantric Yoga meditation were explored in three groups of subjects as they gradually progressed from a phase of normal consciousness into meditation. Groups recruited for the study differed in their level of meditation proficiency. Measurements of skin resistance, heart rate, respiration, autonomic orienting response, resting EEG, EEG alpha and theta frequencies, sleep-scored EEG, averaged evoked responses, and subjective experiences were taken [40].

Unlike most of the previously reported studies on meditation, a study revealed proficient meditators displayed increased autonomic activation during meditation while unexperienced meditators displayed autonomic relaxation during meditation. During meditation, proficient meditators showed increased alpha and theta power, minimal evidence of EEG-defined sleep, and decreased autonomic responses orienting to the external stimulation. An episode of sudden flash of autonomic activation was observed that was classified by the meditator as an approach to the Yogic ecstatic state of intense concentration. These findings challenge the current "relaxation" model of meditative states [40].

Scientific researches have also investigated the physiological changes associated with meditation, previously practiced by the adherents of Indian Yoga, Transcendental Meditation, and Zen Buddhism which has not been able to produce a replicable pattern of responses. Majority of the studies suggest meditation as a wakeful state accompanied by a lowering of cortical and autonomic arousal. The investigations of Zen and Transcendental Meditation have thus by far produced the most consistent and accurate findings. Additional understanding of the underlying mechanisms would require a change in the mindset and shift in the ideologies from old to new and reappraisal of the old hypothesis considering the new ones [41].

Recent researches also indicate that yoga can be effectively implemented for reducing both musculoskeletal conditions and stress. In the workplace, musculoskeletal conditions and stress are two most common reasons for absence of employees from workplace. The World Health Organization has also identified the workplace of an individual as a priority area for promoting good health. As a result of this, yoga is constantly being recommended to uplift the status of wellbeing of the employees. Comprehensive research on relevant electronic databases was performed to determine the effectiveness of yoga in the workplace environments. Eight randomized trials were conducted to meet the inclusion criteria. The results showed that the effectiveness of yoga in the workplace, which was significantly higher for alleviation of musculoskeletal conditions, moderate for perceived stress, limited for sleep quality and conflicting for heart rate variability [42] (Figure 1).



### Effects on High-Risk Dropout School Students

A research was carried out on a 20-session mindful yoga intervention for adolescents who were attending school for assessment of students at high-risk for dropping out. The 50-min classes were offered to the subjects for three times a week. The participants (mean age = 16.7 years) were randomly allocated to intervention and control groups. Multi-rater (student, teacher), multi-method (survey, cognitive, psychophysiological) data were obtained before and after the yoga intervention. Post-intervention it was observed that students in the yoga condition, as compared to control students, exhibited trends towards decreased alcohol use and improved teacher-rated social skills and displayed a non-significant increase in arousal in response to relevant stimuli measured by means of skin conductance. Significant effects were not observed on hypothesized proximal measures of mood, mindfulness, self-regulation, or involuntary engagement coping.

### Impacts on Stress-stricken College Students

College students also experience elevated stress levels that could expose them to develop mental and physical health conditions chronically throughout adulthood. Similarly, exposure to nature has been shown to impart beneficial impacts on human health. A study investigated the physiological and psychological responses of college students to yoga practiced in outdoor versus indoor environments. Fifty-eight college females between the ages of 18-28 were randomly assigned to complete a 40-minute Hatha yoga session either in the indoor environment (empty classroom) or in the outdoor environment (green park) at a mid-sized public university.

Heart rate, respiration rate, perfusion index, and positive and negative effect states were noted in two phases- the pre-yoga phase and the post-yoga phase. Heart rate, respiration rate, and negative effects significantly showed improvements after yoga sessions in cases of both indoor and outdoor environments. Baseline data revealed that the self-reported negative effect was significantly lower in the outdoor group compared to the indoor group. There were no significant interaction relationships between yoga and environment. Thus, the study suggested that a 40-minute-session of Hatha yoga may be a useful method to alleviate acute signs of physiological stress and decrease negative effects for college females exposed to both indoor and outdoor environments [43].

### Impacts on Women Suffering from Chronic Stress

In a similar research a longitudinal investigation of the potential benefits of yoga in a nonclinical sample of chronically stressed women was evaluated. The number of subjects selected for the study were 116. Women were made to undertake a twice weekly, hour-long yoga class for a period of 2 months, and measurements of psychological and physical parameters were taken simultaneously. Changes in both psychological and physical parameters were compared against a wait-list control group. The reported amounts of energy expenditure in both the groups were estimated to be similar, which was indicative of the fact that the control group was engaged in physical activities other than yoga. Of the six psychological outcomes that were measured, improvements were found in three. Specifically, individuals in the practicing yoga group experienced increases in positive effects, decreases in levels of distress and stress,

as well as a significant decrease in waist circumference and increased flexibility. However, no significant differences were found in mindfulness, well-being, and negative effects between the groups [44].

### **Kundalini Yoga and Its Consequences on Physiological Correlates**

The physiological correlates of a highly practiced Kundalini Yoga meditation were explored in another study. Thoracic and abdominal breathing patterns, heart rate (HR), occipital parietal electroencephalograph (EEG), skin conductance level (SCL), and blood volume pulse (BVP) were recorded in three phases—during prebaseline, meditation, and postbaseline. Visual analysis of the data showed a declination in respiration rate during the meditation for the pre- and for the post-baseline phases during the meditation, with a predominance of abdominal/diaphragmatic breathing. There was also an increased generation of alpha EEG activity during the meditation as compared to the pre- and post-baseline periods, and an increase in theta EEG activity was also noted immediately following the meditation as compared to the pre-baseline and meditative periods. These findings suggest that a shift in breathing patterns may manifest to the development of alpha EEG, and those patterns need to be investigated further [45].

### **Impacts on Outcomes of Cardiovascular Health Parameters**

The physiological, psychological, and lifestyle variables associated with cardiovascular health across groups were analyzed and compared in a research. The cross-sectional research examined cardiovascular health markers in long-term practitioners of yoga (yogis), runners, and sedentary individuals. The number of Yogis recruited for the study were 47 and the number of runners recruited for the study were 46 and the number of sedentary individuals were 52. Yogis and runners showed positive profiles as compared to the sedentary individuals in terms of their heart rate, heart rate variability, depression, perceived stress, and cigarette smoking. Runners and male yogis also exhibited superiority in terms of aerobic fitness as compared to the sedentary group.

Runners reported greater social support in comparison to other groups. Yogis demonstrated comparatively lower respiration rate in contrast to sedentary individuals and were more likely to abstain from eating meat compared to other groups. Yogis and runners also demonstrated several cardiovascular health advantages over sedentary individuals. The study was able to infer that there is a possibility that yoga may improve aerobic fitness in men but not women [46]. Parameters like Heart Rate Variability (HRV) and respiratory sinus arrhythmia are directly linked to autonomic flexibility, self-regulation, and well-being, and inversely related to magnitudes of physiological stress, psychological stress, and pathology. Yoga is also thought to enhance the levels of autonomic activity, mitigate stress and

benefit stress-related clinical conditions, yet the relationship between psychophysiological responses of yoga and stressful stimuli with autonomic activity has not been widely investigated.

An experimental study explored the relationship between HRV, mood states and the respective flow experiences in regular yoga practitioners (YP), non-yoga practitioners (NY) and people having metabolic syndrome (Met S), in course of the Mental Arithmetic Stress Test (MAST) and various yoga practices. It was observed that the MAST placed a cardio-autonomic burden in all the participants with the YP group showing the highest reactivity and the most rapid recovery, while the Met S group had significantly slower recovery. The YP group also showed an elevated experience of flow and positive mood states compared to NY group and the Met S group as well possessed a higher vagal tone during all resting conditions. These results suggest yoga practitioners have a greater homeostatic capacity and autonomic, metabolic, and physiological resilience as compared to the non-practitioners [47].

### **Efficacy of Yoga on Patients Suffering from Cancer**

An investigation was carried out on seventy patients, of whom 20% were males and 80% were females of age 18 years or above. All patients were under treatment at the oncology department for gastrointestinal, mammary, or genital carcinoma, and the disease was metastatic in 80% of the patients. Data was collected between the period of April 2013 and May 2017. The protocol mainly comprised of a weekly 90-minute Yoga lesson for 8 consecutive weeks, and the data collection was done in 2 phases: (T0) pre-protocol assessment and (T1) post-protocol assessment. Assessment of the psychophysiological parameter was carried out with the following scales: the (BFI) Brief Fatigue Inventory, (HADS) Hospital Anxiety and Depression Scale and (PSQI) Pittsburgh Sleep Quality Index.

Analysis of data revealed a significant difference between the (T0) and (T1) HADS (Hospital Anxiety and Depression Scale) scores. The scale was mainly constituted of psychological variables for the in-depth assessment of anxiety and depression. In contrast, scores from the (BFI) Brief Fatigue Inventory and (PSQI) Pittsburgh Sleep Quality Index did not show any significant differences between (T0) and (T1): such scales were relative to the psychophysiological variables for the assessment of the fatigue perception and sleep quality. A noteworthy finding of the study was also that the data, once analyzed, showed significant differences in pre-protocol and post-protocol anxiety and depression levels but not in the fatigue perception or the sleep quality.

In accordance with the scientific literature review, data collected from the study was able to highlight that practicing Yoga may promote changes in the levels of perceived anxiety and depression in patients who were in the phase of undergoing treatment of cancer. It was also clear that there was a significant difference between the psychological and physiological variables

being considered in the study and statistically significant figures were observed only in levels of anxiety and depression. Moreover, other directions for future clinical research regard the evaluation of the reason for the possible denial to participate in this kind of study, as well as the social-cultural differences in patient's behavior [48].

### Effects on Students During COVID-19

The effects of coronavirus disease 2019 (COVID-19) pandemic have raised health concerns across the globe. Medical and allied health professional schools have been seeking for ways and effective coping mechanisms to alleviate stress and improve the quality of life among students. Yoga and its impacts have proven to be successful against stress. The levels of mental stress among these students are known to be much greater than that of the general population. Sudden change in circumstances due to the pandemic have likely impacted these students.

Some of these circumstances include uncertainties concerning teaching, learning and assessment which generated stress and anxiety, and social distancing which further contributed to loneliness, anxiety, depression. Yoga has gained recognition not only in inducing improvements in mental health parameters and quality of life, but it also helps in improving the status of respiratory and immune health systems. Although several previous studies have examined the psychophysiological effects of yoga among health professional students; only a few medical and allied health professional schools have incorporated yoga into their diurnal curriculum as a holistic approach. With respect to the COVID-19 crisis, the use of yoga for stress reduction and immune modulation has been considered as a complement to other treatments. There is also a requirement to integrate yoga into medical and health science curriculum to prepare physically fit and mentally sound prospective healthcare professionals [49].

### Yoga and Music Therapy for Heart Patients

Patients undergoing cardiac catheterization and coronary angiography often seem to experience higher levels of anxiety and physiological perturbations. In those cases, music therapy and music interventions have been found to be effective in descending the levels of anxiety and reducing the physiological disturbances for these patients. However, the efficacy of amalgamation of music and yoga therapies for pre-procedural anxiety and physiological disturbances has still to be explored. A study was conducted aiming on the comparison of the effects of music therapy with the combination of music and yoga therapies on the psycho-physiological responses like blood pressure, pulse rate, respiratory rate and anxiety of patients who were allocated for undergoing coronary angiography. A total of 45 patients who were appointed for coronary angiography were included in the study and randomly assigned to three groups.

The Music therapy group(n=16) received music listening

intervention in the form of listening to patient-preferred, pre-recorded, relaxing raga improvisational music for a time duration of 15 minutes in two phases- on the previous day of angiography and 15 minutes before being taken to the catheterization lab on the day of the angiography. The other group (Yoga in combination to music group) received both yoga therapy and music therapy in the form of pranava pranayama together for a time duration of 15 minutes. Standard medical treatment was provided to the control group. The Likert scale was used for measuring the anxiety levels by a five-point single item and the physiological measures such as systolic blood pressure (SBP), diastolic blood pressure (DBP), respiratory rate (RR) and pulse rate (PR) were also recorded. Both music therapy alone group and the combination of music and yoga therapies group showed significant reduction in anxiety and respiratory rate and the music therapy group recorded additional significant reductions in SBP, DBP and PR scores during the intervention period. Thus, it was concluded that music therapy alone can bring down the anxiety levels and minimize the levels of physiological disturbances of patients being appointed for angiography. Also, combination of music and yoga therapies can bring down the anxiety levels and can better the deep breathing pattern for these patients [50].

### Psychophysiology of Laughter Yoga

Laughter yoga is supposed to have similar psychological and physiological effects like exercising. studies were reported with the objective of examining the visual and practice effects of laughter yoga in women. The first study was performed with 13 young women (mean age =21.92 ± SD = 1.66 years) who were made to experience laughter yoga visually. The second study was explored on 25 older women (mean age = 63.83 ± SD = 11.91 years) in course of an in-situ laughter yoga class. It was observed that there was no significant relationship existing between the humor styles, expectancy, and the magnitude of psychological measure changes, neither in case of visual laughter yoga nor in the practice experience of laughter yoga.

In Study 1, The negative effects decreased significantly while feeling states, heart rate, and respiration rate remained increased because of exposure to visual laughter yoga. In Study 2, feeling states, felt arousal, positive effect, and negative effect, post practice class of laughter yoga. More intriguingly, heart rate also increased, and the basal metabolic rate during the class was considerably comparable to that of light to moderate physical activity. Since, laughter yoga is characterized by positive psychological and cardiometabolic changes, it could easily exemplify a pleasurable, healthy, and a secure form of recreation for all [51].

Yoga and meditation together, can effectively eradicate stress, anxiety, mood disturbance, and musculoskeletal problems, and can improve cognitive and physical performance. Professional musicians experience significantly higher levels of stress,



performance anxiety, and debilitating performance-related musculoskeletal disorders (PRMDs). A study was conducted to evaluate the beneficial effects of yoga and meditation for musicians. During the study, young adult professional musicians participated in a 2-month program of yoga and meditation and were randomized either to a yoga lifestyle intervention group ( $n = 15$ ) or assigned to a group practicing yoga and meditation ( $n = 15$ ). Additional musicians were recruited to a control group who did not undergo any practice ( $n = 15$ ). Both the yoga groups attended three Kripalu Yoga or meditation classes each single week.

The yoga lifestyle group also experienced weekly group practices and moderate discussion sessions as part of their immersive treatment. All participants completed the intervention self-report questionnaires that evaluated music performance anxiety, mood, PRMDs, perceived stress, and sleep quality; many participants post-study, completed a 1-year follow-up assessment making use of the same questionnaires. Both the yoga groups showed a less music performance anxiety and significantly less general anxiety/tension, depression, and anger at end-program in contrast to the control group, but showed no changes in PRMDs, stress, or sleep. Similar results in the two yoga groups, suggested that the yoga and meditation techniques themselves may have pivoted the improvements. Thus, the study inferred that yoga and meditation techniques can effectively reduce performance anxiety and mood disturbances in young professional musicians [52].

### Effects on Patients with Idiopathic Epilepsy

Sahaj meditation and its effects were investigated on 32 patients with primary idiopathic epilepsy undergoing maintained and regular antiepileptic medication. The patients recruited for the study were randomly assigned into 3 groups: group I practiced Sahaja Yoga meditation twice daily for a time of 6 months under proper guidance, group II practiced postural exercises imitating the meditation for the same duration, and group III was the control group. Visual Contrast Sensitivity (VCS), Auditory Evoked Potentials (AEP), Brainstem Auditory Evoked Potentials (BAEP), and Mid Latency Responses (MLR) were monitored initially (at the 0 month) and at 3 and 6 months for each of the groups.

Significant improvement was observed in VCS following meditation practice in group I participants. Na, the first MLR prominent negative peak and Pa, the MLR positive peak following Na did not record any changes in latency. The Na-Pa amplitude of MLR also showed increases significantly. No significant changes were observed in the absolute and inter-peak latencies of BAEP. The decreased stress levels following meditation practice may make patients more responsive to specific stimuli. Sahaja Yoga meditation, thus, was able to bring about changes in some of the electrophysiological responses studied in epileptic patients [53].

### Effects of Alternate Nostril Breathing on Physiological Indices

In an investigation, the effects of right, left, and alternate nostril yoga breathing (i.e., RNYB, LNYB, and ANYB, respectively) were compared with breath awareness and normal breathing groups. Autonomic and respiratory variables were studied. 21 male volunteers with ages ranging between 18- and 45-years having experiences in yoga breathing practices between 3 and 48 months were recruited for the study. Subjects were evaluated on five experimental sessions on five separate days. The sessions were in definite possible sequences and subjects were assigned to a specific sequence randomly. Each session was for 40 min; 30 min for the breathing practice, preceded and followed by 5 min of relaxed sitting. Skin conductance, heart rate variability, breath rate, finger plethysmogram amplitude, blood pressure were assessed. Post- RNYB there was a significant increase in systolic, diastolic, and mean pressure. In contrast, the systolic and diastolic pressure levels declined after ANYB, and the systolic and mean pressure levels were significantly lower post exposure to LNYB. Thus, unilateral nostril yoga breathing practices seemed to possibly influence the blood pressure in different ways [54].

### Influences of Regular Exercise and Emotional Intelligence on Stress

An exploration also highlighted the effects of regular exercise and emotional intelligence on coping with stress levels in adolescents. During the study, neuro-physiological mechanism involved in exercise induced processes of combating stress have been surveyed in inclusion to the psychophysiological way of emotional intelligence in adolescents in managing stress levels. Impacts of gender variation in stress response and coping strategy have also been investigated in the target age group. The available literature emphasized on the constructive neuro-physiological role of exercise on significant stress reduction among adolescents. Previous researches also indicated that participation in emotional intelligence (EI) development programmes and exposure to regular exercise training are potentially effective tools in outshining stress mediated turmoil in adolescents in terms of both their personal and community life. The literature also recommended the inclusion of regular exercise programmes and practice of emotional intelligence skill in mainstream school curriculum as compulsory activity for students in adolescence stage for attaining better health and lifestyle in the future [55].

### Impacts on Judo and Karate Players

A study was also conducted focusing on the evaluation of the pulmonary function in male Indian Judo and Karate players and comparison of the data with their sedentary control and overseas counterparts. State level young male non-smoking Judo ( $n=30$ ) and Karate ( $n=30$ ) players with minimum five years

of regular involvement in training were recruited for the study who were associated with different sports academies of Kolkata, India. Non-smoking sedentary control (n=30) subjects were recruited who belonged to the same socio-economic background. Physical parameters and pulmonary functions were measured by standard methods. Apart from age and body height, all the physical and physiological parameters were significantly higher in the sedentary control group. The Tidal volume, vital capacity (VC), forced vital capacity (FVC), forced expiratory volume in 1 second, percentage of forced vital capacity and peak expiratory flow rates depicted significantly higher values in Judo and Karate groups in contrast to their sedentary counterparts.

Age, body height and body mass were found to be significantly correlated with the lung function parameters. Simple and multiple regression equations were implemented for predicting pulmonary functions in the study population. It was concluded that training in Martial arts like Judo and Karate and exposure to concomitant meditative exercise routines significantly improved pulmonary function in the athletes [56]. Another study examined the sex-variation in high-intensity exercise induced oxidative stress and muscle damage parameters. 44 sedentary post-pubertal boys and girls were recruited for the study. Assessments were based on the estimation of post-exercise release pattern of muscle damage markers like creatine kinase, lactate dehydrogenase (LDH), alanine aminotransferase (ALT), aspartate aminotransferase (AST) and was also inclusive of the oxidative stress markers like lipid peroxidation (thiobarbituric acid-reactive substances) and catalase activity.

Muscle damage markers like creatine kinase, LDH, ALT, and AST were measured in three phases- before, immediately after, and after 24 and 48 hours of high-intensity incremental treadmill running. Oxidative stress markers like catalase and thiobarbituric acid activities were estimated before and immediately after the exercise. Lipid peroxidation and serum catalase activity increased significantly after exercise in both the groups with post-exercise values and percentage increase significantly higher in post-pubertal boys as compared to girls. Creatine kinase and LDH activity also increased significantly at pre-exercise level at 24 and 48 hours after exercise in both the sexes, with values significantly higher for boys than the girls. Though, ALT and AST significantly increased in both the groups after exercise, the post-exercise release pattern of these markers were found to be similar in case of both the groups. Thus, it was concluded that high-intensity exercise induces significant oxidative stress and increases exponents of skeletal muscle damage in both post-pubertal girls and boys. However, post pubertal girls are comparatively better protected from oxidative stress and muscle damage in contrast to the boys of similar age and physical activity level [57].

### Asanas and Their Role in Psychophysiological Regulations

Asana (posture) is usually conceptualized as a body posture

held with stability and ease by Patanjali. Hathayoga Pradipika mainly lays stress on the fact that asana helps in inducing stability in health and suppleness of the body. As intra-thoracic, intra-abdominal pressure-volume changes affect internal organs and systems, it is plausible that asanas can bring about changes through mechanisms both local as well as general. Some examples are changes in energy expenditure, ventilatory responses, glucose metabolism, oxygen consumption as well as respiratory, neuromuscular, and cardiovascular parameters. Investigation on neuromuscular reflex arcs dynamics showed that position asana is an excellent system to restore balance and psychosomatic harmony. Asanas generally accrue benefits which are of a psychosomatic nature while it strives for yielding somato-psyche benefits. It is suggested that Hathayoga helps us develop primitive sub-human tendencies thus inducing all round improvements in human and humane qualities [58-60].

### Practical implications

Based on the research evidences available, it can be suggested that yoga has its own significance and uniqueness on impacting the psychophysiological sphere of life. Moreover, in terms of the applications and clinical implications of yogic postures, yoga now has been able to achieve a state where it is extensively adopted as an alternate to medicine therapy since it is widely recommended by physicians, chiropractors etc. globally. Patients in quest of an alternate to surgical and medicinal treatments are acquiring yoga extensively in their lifestyles. Implementation of large-scale yoga interventions has emerged to be a boon in alleviation and minimization of stress from various aspects. Apart from being beneficial from the spiritual and intellectual dimensions, yoga also caters as a superlative stress alleviator and a magnificent restorer of physiological homeostasis.

### Conclusion

It is evident from this review that yoga in inclusion to its versatility today, is indeed a unique non-invasive concept for stress alleviation. On one hand, it decreases the level of anxiety by minimizing the sympathetic hyperactivity potentially induced by stress reducing the chances of atherosclerosis, chances of heart failure and ischemia by enhancing the regulation of the cardiovascular hemodynamics, blood lipid levels and functioning of the blood vessels. Moreover, practices of yoga postures also strengthen intercostal muscles, thereby expanding the lung volumes and capacities which improve the cardiorespiratory fitness by enhancing the oxygen uptake. On the other hand, in terms of endocrine regulation, yoga rejuvenates the pancreatic endocrine function that in turn maintains the blood glucose homeostasis in a better fashion.

It also stimulates vagus nerve that decreases the frequency of epileptic seizures by 28-38% and causes modulation of brain waves and the limbic system. Increased vagal activity reduces the heart rate and vice versa. Yoga also increases the production of hormones like endorphin thereby increasing the oxygen supply to the brain. Rapidly emerging in the Western world,

Yoga has been accepted today as a facility which strives towards unification of the body and the mind into the harmony. It is believed to better the status of mental, physical, and spiritual health and also proffer mechanisms that exterminate stress. At present, more pharmacological and psychological interventions are prioritized as therapies.

However, the popularity of the concept of adopting techniques of mind-body interactions has been globally increased now-a-days and ultimately implemented through yogic interventions in regular lifestyle to cultivate holistic wellness of human being. Improvements in terms of relaxation, self-confidence, efficiency and optimistic outlook of life are seen upon periodic exposure to yoga and pranayama interventions. Moreover, awareness of Yoga by means of various campaigns and programmes are assisting people in search of tranquility and providing a better scope of understanding the various components of life. Practice of yoga with utmost wisdom is what one should aim for, to cope up with self-actualization, achieving needs and individual goals.

## References

- Butera R (2006) *Complementary and Alternative Medicine for Older Adults: A Guide to Holistic Approaches to Healthy Aging*, Springer Publishing Company, Inc, New York, US, pp. 199-213.
- Bragdon C (2018) *An Introduction to Yoga* (2018 Edition), Routledge, Milton Park, Abingdon, Oxfordshire, England, UK, pp. 15-16.
- Khalsa SB (2007) *Principles and practice of stress management* (3), Guilford Press, NY, US, pp. 449-462.
- Alter JS (2021) *Yoga in Modern India* (2021 Edition), Princeton University Press, Princeton, United States pp. 376.
- Jammu JPS (2016) Yoga tourism in India. *Int J Inf Move* 1(8): 1-6.
- Hidaka BH (2012) Depression as a disease of modernity: explanations for increasing prevalence. *J Affect Disord* 140(3): 205-214.
- Little N (2007) *Depression Treatment Options*.
- Richter S, Tietjens M, Ziereis S, Querfurth S, Jansen P (2016) Yoga training in junior primary school-aged children has an impact on physical self-perceptions and problem-related behavior. *Front Psychol* 7: 203.
- Rahnama N, Namazizadeh M, Etemadifar M, Bambaiechi, Arbabzadeh S, et al. (2011) Effects of Yoga on Depression in Women with Multiple Sclerosis. *J Isfahan Med Sch* 29(136): 483-490.
- Duan Porter W, Coeytaux RR, McDuffie JR, Goode AP, Sharma P, et al. (2016) Evidence maps of yoga for depression, anxiety, and posttraumatic stress disorder. *J Phys Act Health* 13(3): 281-288.
- Shohani M, Badfar G, Nasirkandy MP, Kaikhavani S, Rahmati S, et al. (2018) The effect of yoga on stress, anxiety, and depression in women. *Int J Prev Med* 9: 21.
- Maddux RE, Daukantaitė D, Tellhed U (2018) The effects of yoga on stress and psychological health among employees: an 8-and 16-week intervention study. *Anxiety, Stress and Coping* 31(2): 121-134.
- Patton GC, Coffey C, Romaniuk H, Mackinnon A, Carlin JB, et al. (2014) The prognosis of common mental disorders in adolescents: a 14-year prospective cohort study. *Lancet* 383(9926): 1404-1411.
- Hunt J, Eisenberg D (2010) Mental health problems and help-seeking behavior among college students. *J Adolesc Health* 46(1): 3-10.
- Wong CA, Taylor JA, Wright JA, Opel DJ, Katzenellenbogen RA (2013) Missed opportunities for adolescent vaccination, 2006-2011. *J Adolesc Health* 53(4): 492-497.
- US National Library of Medicine (2018). *National Institutes of Health Collection Development Manual, Complementary and Alternative Medicine*.
- Segal ZV, Teasdale JD, Williams JMG (2004) *Mindfulness and acceptance: Expanding the cognitive-behavioral tradition* (Illustrated Edition), Guilford Press, New York, NY, US, pp. 45-65.
- Salagame KKK (2010) *Yoga-The Light of Microuniverse* (2010 Edition), Yoga Federation of Serbia, Gandijeva 101, 11070 Novi Beograd, Belgrade, Serbia pp. 41-55.
- Sheftel I, Sips A (2021) *Handbook of Research on Evidence-Based Perspectives on the Psychophysiology of Yoga and Its Applications* (2020 Edition), IGI Global, Hershey, Pennsylvania, US, pp. 124-142.
- Narain AK (1980) *Studies in the history of Buddhism* (2010 Edition), Buddhist World Press, Delhi, Uttar Pradesh, India, pp. 421.
- Rao KR, Paranjpe AC (2008) *Handbook of Indian Psychology*. (2008 Edition), Foundation Books, Shaftesbury Road, Cambridge, UK, pp. 186-206.
- Balaji PA, Varne SR, Ali SS (2012) Physiological effects of yogic practices and transcendental meditation in health and disease. *N Am J Med Sci* 4(10): 442-448.
- Tandon OP (2012) *Best and Taylor's Physiological Basis of Medical Practice*. (13th Edition), Gurgaon: Wolters Kluwer health/ Lippincott Williams and Wilkins publishers, Gurgaon, Haryana, India, pp. 1217-1230.
- Sahay BK, Murthy KJR (1988) Long term follow up studies on effect of yoga in diabetes. *Diabetes Res Clin Pract* 5(suppl 1): S655.
- McCall, T. (2016) The scientific basis of yoga therapy. article online) *Yoga Journal*, available from <http://www.yogajournal.com/teacher/2016.cfm>.
- Chandratreya S. *Diabetes & Yoga*. (Accessed Jun 16, 2012, at [http://www.yogapoint.com/therapy/diabetes\\_yoga.htm](http://www.yogapoint.com/therapy/diabetes_yoga.htm)).
- Delmonte MM (1985) Biochemical indices associated with meditation practice: a literature review. *Neurosci. Biobehav Rev* 9(4): 557-561.
- Tulpule TH, Shah HM, Shah SJ, Haveliwala HK (1971) Yogic exercises in the management of ischaemic heart disease. *Indian Heart J* 23(4): 259-264.
- Manjunatha S, Vempati RP, Ghosh D, Bijlani RL (2005) An investigation into the acute and long-term effects of selected yogic postures on fasting and postprandial glycemia and insulinemia in healthy young subjects. *Ind J Physiol Pharmacol* 49(3): 319-324.
- Ramaiah SA (1986) *Yoga Therapy for Diabetes: Washington, DC Study*. International Conference on Traditional Medicine, India.
- Yogalink. A community service donated by samyama yoga. (Accessed Jul 9, 2012, at <http://www.yogalink.com.au>).
- Jerath R, Edry JW, Barnes VA, Jerath V (2006) Physiology of long pranayamic breathing: neural respiratory elements may provide a mechanism that explains how slow deep breathing shifts the autonomic nervous system. *Med Hypotheses* 67(3): 566-571.
- Wallace RK, Benson H, Wilson AF (1971) A wakeful hypometabolic physiologic state. *Am J Physiol* 221(3): 795-799.
- Tooley GA, Armstrong SM, Norman TR, Sali A (2000) Acute increases in night-time plasma melatonin levels following a period of meditation. *Biol Psychol* 53(1): 69-78.
- Schmalzl L, Jeter P, Khalsa SBS (2020) *Routledge Handbook of Yoga and Meditation Studies* (1st Edition), Routledge, Milton Park, Abingdon, Oxfordshire, England, UK, pp. 440-459.

36. Moss D (2011) Yoga, Meditation, and Applied Psychophysiology. *Biofeedback* 39(2): 43-44.
37. Raub JA (2002) Psychophysiological effects of Hatha Yoga on musculoskeletal and cardiopulmonary function: a literature review. *J Altern Complement Med* 8(6): 797-812.
38. Malathi A, Damodaran A, Shah N, Krishnamurthy G, Namjoshi P, et al. (1998) Psychophysiological changes at the time of examination in medical students before and after the practice of yoga and relaxation. *Indian J Psychiatry* 40(1): 35-40.
39. Tripathi MN, Kumari S, Ganpat TS (2018) Psychophysiological effects of yoga on stress in college students. *J Educ Health Promot* 7: 43.
40. Corby JC, Roth WT, Zarcone VP, Kopell BS (1978) Psychophysiological correlates of the practice of Tantric Yoga meditation. *Arch Gen Psychiatry* 35(5): 571-577.
41. Woolfolk RL (1975) Psychophysiological correlates of meditation. *Arch Gen Psychiatry* 32(10): 1326-1333.
42. Hartfiel N, Edwards RT (2020) *Alternative Pain Management: Solutions for Avoiding Prescription Drug Overuse*. (1<sup>st</sup> Edition), IGI Global, Hershey, Pennsylvania, US, pp. 254-264.
43. Dietrich K, Bidart MG (2021) Hatha Yoga Improves Psychophysiological Responses of College Students in Both Indoor and Outdoor Environments. *OBM Int Comp Med* 6(4): 1-14.
44. Harkess KN, Delfabbro P, Mortimer J, Hannaford Z, Cohen-Woods S (2016) Brief report on the psychophysiological effects of a yoga intervention for chronic stress. *J Psychophysiol* 31(1): 38-48.
45. Arambula P, Peper E, Kawakami M, Gibney KH (2001) The physiological correlates of Kundalini Yoga meditation: a study of a yoga master. *Appl Psychophysiol Biofeedback* 26(2):147-153.
46. Satin JR, Linden W, Millman RD (2014) Yoga and psychophysiological determinants of cardiovascular health: comparing yoga practitioners, runners, and sedentary individuals. *An Behav Med* 47(2): 231-241.
47. Tyagi A, Cohen M, Reece J, Telles S, Jones L (2016) Heart rate variability, flow, mood and mental stress during yoga practices in yoga practitioners, non-yoga practitioners and people with metabolic syndrome. *Appl Psychophysiol Biofeedback* 41(4): 381-393.
48. Mirandola M, Sabogal Rueda MD, Andreis F, Meriggi F, Codignola C, et al. (2019) Yoga protocol for cancer patients: a systematic exploration of psychophysiological benefits. *Rev Recent Clin* 14(4): 261-268.
49. Sarkar S, Sa B, Singh K, Gaur U, Bharatha A, et al. (2021) Psychophysiological effects of yoga on stress management among medical and allied health professional students during COVID-19 Pandemic: A Narrative review. *Adv Hum Biol* 11(4): 3-12.
50. Ajmera S, Ganesh BA, Bhavanani AB, Dayanidy G (2018) A comparative study on the effect of music therapy alone and a combination of music and yoga therapies on the psychophysiological parameters of cardiac patients posted for angiography. *SBV j. basic clin appl health sci* 1(1): 13-18.
51. Szabo A, Berkes T, Ihász F, Köteles F (2021) Psychophysiological Responses to Laughter Yoga in Women: Two Studies on the Visual and Practice Effects of this New Physical Activity. *Balt j sport health sci* 4(123): 23-34.
52. Khalsa SBS, Shorter SM, Cope S, Wyshak G, Sklar E (2009) Yoga ameliorates performance anxiety and mood disturbance in young professional musicians. *Appl Psychophysiol Biofeedback* 34(4): 279-289.
53. Panjwani U, Selvamurthy W, Singh SH, Gupta HL, Mukhopadhyay S, et al. (2000) Effect of Sahaja yoga meditation on auditory evoked potentials (AEP) and visual contrast sensitivity (VCS) in epileptics. *Appl Psychophysiol Bio feedback* 25(1): 1-12.
54. Raghuraj P, Telles S (2008) Immediate effect of specific nostril manipulating yoga breathing practices on autonomic and respiratory variables. *Applied Psychophysiol Biofeedback* 33(2): 65-75.
55. Das S, Halder K, Bandyopadhyay A (2016) Three Dimensional Relationships of Emotional Intelligence, Exercise and Stress in Adolescents. *Adv Appl Physiol* 1(1): 1-7.
56. Dalui R, Bandyopadhyay A (2017) Pulmonary Function of Young Indian Male Judo and Karate Players. *Biol. Exerc* 13(1): 33-43.
57. Pal S, Chaki B, Chattopadhyay S, Bandyopadhyay A (2018) High-intensity exercise induced oxidative stress and skeletal muscle damage in postpubertal boys and girls: A comparative study. *J Strength Cond Res* 32(4): 1045-1052.
58. Bhavanani AB, Ramanathan M (2018) *Research-based perspectives on the psychophysiology of yoga*, IGI Global, Pennsylvania, USA, pp. 1-16.
59. Dang KK, Sahay BK (1999) Yoga and meditation. *J Assoc Physicians India* 9(1): 502-512.
60. Fishbein D, Miller S, Herman Stahl M, Williams J, Lavery B, et al. (2016) Behavioral and psychophysiological effects of a yoga intervention on high-risk adolescents: A randomized control trial. *J Child Fam Stud* 25(2): 518-529.



This work is licensed under Creative Commons Attribution 4.0 License  
DOI: [10.19080/JPFMTS.2023.10.555780](https://doi.org/10.19080/JPFMTS.2023.10.555780)

## Your next submission with Juniper Publishers will reach you the below assets

- Quality Editorial service
- Swift Peer Review
- Reprints availability
- E-prints Service
- Manuscript Podcast for convenient understanding
- Global attainment for your research
- Manuscript accessibility in different formats  
( Pdf, E-pub, Full Text, Audio)
- Unceasing customer service

Track the below URL for one-step submission

<https://juniperpublishers.com/online-submission.php>