



EVALUATION OF THE EFFECTIVENESS OF YOGA AS A HEALTH INTERVENTION ON THE COGNITIVE BEHAVIOUR OF YOUNG, HEALTHY SUBJECTS

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ABSTRACT:

Yoga is an effective remedy for a wide range of physical and psychological ailments. Yoga elicits deep transformations in the physiological and psychological aspects of the individual who does it. The goal of this study is to use physiological markers to examine how yoga affects mental agility, the autonomic nervous system, and HRV. Methods. Thirty healthy, young engineering students participated in the research. They were divided into two groups at random: one that practiced yoga and another that did not. The yoga group met for five months, during which time they practiced for an hour and a half six days a week. Final product. The group that practiced yoga had significantly lower θ and γ band powers and higher α , β , and δ EEG band powers. Enhanced cognitive abilities like memory and focus may be represented by higher α and β power, while synchronisation of brain activity is shown by δ . The ratio dropped, the heart rate index went down, the brain activity β/θ went up, the attention resource index went up, the executive load index went down, and the heart rate index went down. Heart rate variability, SDNN/RMSSD, and the LF/HF ratio were all improved in the yoga practice group. Final thoughts. There was a considerable uptick in performance enhancement, brain activity, attention, and executive function in the yoga group. Parasympathetic nervous system activity, balanced autonomic nervous system reactivity, and heart rate variability all saw increase as a consequence.

KEY WORDS : Yoga, EEG, Relaxation Vibro-Acoustic, Bhramari Pranayama, Ardha Chakrasana, Bhramari Pranayama, Naukasana.

1.INTRODUCTION:

Pranayama is a breathing practice. The act of breathing allows us to get an ample supply of oxygen, which serves as essential nourishment for our muscles and blood. Pranayama is a combination of the terms 'prana' and 'yama', which refers to the preservation of prana in a state of well-being throughout one's lifetime. Pranayama is primarily focused on regulating the life energy, known as prana, rather than being only a breath control exercise. Patanjali's Yoga Sutra states that pranayama allows the mind to develop the ability to focus on any chosen object of attention. Additionally, it states that using scientific breathing techniques facilitates the revelation of genuine knowledge by dispelling the obscurity of ignorance. [1]

Having a healthy mental and emotional state:

The connection between the mind and the body: Yoga is a practice that fosters a profound connection between the mind and the body. via the cultivation of awareness via practice, people are able to build mindfulness, which enables them to be present in the moment and gain a deeper knowledge of their own thoughts and feelings.

Managing Stress: [Stress Management] The ability to effectively handle stress is essential for general well-being in a society that is constantly bombarding us with stimuli. By educating practitioners to respond to obstacles with composure and resilience rather of responding impulsively, yoga provides skills for stress reduction and teaches practitioners how to respond to challenges.[2]

Increased clarity and concentration are the third benefit. The practice of meditation, which is an essential part of yoga, is beneficial for sharpening the mind and improving focus. The practice of meditation on a regular basis has been associated with improvements in cognitive function, creativity, and the ability to make decisions.

Certain Aspects of Spirituality and Ethics:

1. A connection to a higher purpose is the first point. Yoga is a practice that goes beyond the physical and mental components and explores the world of the spiritual. A number of yoga traditions place an emphasis on the concept of establishing a connection with a higher purpose or awareness, which helps to cultivate a feeling of inner serenity and purpose.

2. "Yamas and Niyamas:" [Pure Yoga] The ethical precepts of yoga, which are also referred to as yamas and niyamas, provide practitioners a framework that is both moral and spiritual in nature. These principles, which encompass notions like as non-violence, honesty, contentment, self-discipline, and surrender, are designed to direct people towards a manner of life that is more attentive and compassionate.[3]

2. REVIEW OF LITERATURE :

Electroencephalography (EEG) and the Study of Brain Waves

The introduction of electroencephalography (EEG) in 1929 by German psychiatrist Hans Berger was a significant milestone in the field of neurology and psychiatry. This discovery provided a novel diagnostic tool, particularly considering the absence of modern techniques such as evoked potentials (EP), computed tomography (CT), magnetic resonance imaging (MRI), and digital subtraction angiography (DSA). Without these advanced technologies, the ability to diagnose neurological conditions and plan ne Brain waves are the manifestation of the electrical activity generated by the brain. [4]When a cluster of neurons emits a series of electrical impulses to another cluster of neurons, it generates a pattern like a wave. The measurement of these waves is expressed in terms of the frequency of cycles per second, known as Hertz (Hz). Brain wave activation refers to the electrical activity of neurons in the brain, which is caused by voltage variations resulting from the movement of ions inside the neurons. The electrical activity is captured using an electroencephalogram (EEG), which depicts this activity as waves or oscillations.

These oscillations correspond to distinct functions occurring throughout the brain.

Alpha waves refer to brain oscillations occurring at a frequency of 8-13 Hz, namely inside the cortex, occipital lobe, and thalamic regions. Alpha waves have significant magnitudes and manifest at states of considerable cerebral engagement. Alpha waves are generated when a person is in a state of temporary inactivity yet remains attentive. It is common for substantial quantities of these waves to occur when sleeping or in a sleepy condition. Alpha waves have the functional ability to suppress some regions of the cortex and are crucial for facilitating communication among neurons.

Beta waves, which have a frequency of 12-38 Hz, are present when an individual is in a state of heightened consciousness, in contrast to alpha waves. Beta state refers to a certain pattern of brain oscillation that occurs at the completion of a task and during periods of focused concentration. Beta waves are very prevalent in the motor cortex during isotonic contractions and sluggish motions.[5]

Theta waves Theta waves, sometimes referred to as theta rhythm, manifest when a repeated job reaches a state of autonomy, requiring little concentration to be accomplished. The theta state is essentially achieved when the task(s) are accomplished in a recognisable and regular manner.

Gamma waves refer to brain oscillations that manifest at a frequency range of 40-100 Hz. These brain waves have been hypothesised to be associated with conscious attention. Prior studies have shown that gamma waves are generated in the thalamus and propagate in an anterior direction as they induce synchronisation of neuronal activity.

Delta waves refer to the slowest brain waves seen in humans. These sleep patterns are most often seen in newborns and young children, and are linked to the most profound states of relaxation and rejuvenating, therapeutic sleep. Delta waves are often seen in cases of brain injuries, cognitive impairments, difficulties in cognitive processing, and severe attention deficit hyperactivity disorder (ADHD). The frequency ranges from 1 to 4 Hz.

Electroencephalography (EEG) is a non-invasive technique used to assess and record the electrical activity in the brain. Multiple research have examined the impact of engaging in yoga on EEG patterns, providing intriguing revelations about the influence of this ancient practice on brain activity.

2.1 EFFECT OF YOGA ON EEG

The effects of practicing yoga on EEG are diverse, impacting many frequency bands and brain areas.

1. Heightened Alpha Wave Activity: - A recurring observation in electroencephalogram (EEG) research on individuals who practise yoga is an augmentation in alpha wave activity. Alpha waves, characterised by a frequency range of 8-13 Hz, are linked to a state of consciousness that is both relaxed and alert. Yoga, specifically the techniques of meditation and mindfulness, have been associated with increased alpha power, which suggests a state of mental tranquilly and concentrated concentration.

2. Theta Wave Enhancement: - Theta waves, which oscillate at a frequency range of 4-8 Hz, are linked to profound relaxation, meditation, and the stimulation of creative thinking. Several studies indicate that consistent engagement in yoga might result in heightened theta wave activity. This change may be associated with the contemplative elements of yoga, as well as the deliberate regulation of respiration and physical actions.

3. Enhanced Coherence and Synchronization: - Yoga practices that include synchronised movements, breath regulation, and meditation have been shown to improve the coherence and synchronisation of brain activity. Enhanced interconnectivity across distinct brain areas, as shown by EEG coherence measurements, is linked to enhanced cognitive performance, emotional control, and general integration of the brain.

4. Activation of Gamma Waves: - Gamma waves, which have frequencies above 30 Hz, are linked to advanced cognitive processes such as memory, attention, and perception. Several studies indicate that engaging in advanced yoga techniques, such as meditation, might potentially result in heightened gamma wave activity. The increased gamma activity is thought to be linked to improved cognitive processing and mental clarity.

5. Alterations in Frontal Alpha Asymmetry: - Frontal alpha asymmetry, which refers to the discrepancy in alpha strength between the left and right frontal brain areas, has been examined in connection with emotional processing and mood control. The practice of yoga, especially when focusing on mindfulness and breath control, has been linked to alterations in frontal alpha asymmetry, indicating possible beneficial impacts on emotional well-being.

6. Stress Reduction and Cortical Alpha Suppression: - Prolonged stress has been shown to be linked with heightened cortical alpha activity. Yoga, as a method to reduce stress, has been shown to decrease alpha power in the cortical areas, suggesting a physiological reaction to stress reduction. This aligns with the soothing and tranquillizing effects that several folks have reported experiencing after their yoga practice.

2.2 YOGA AN AID TO STUDY OF HEALTH :

To summarise, EEG investigations provide useful insights into the neurophysiological alterations linked to the practice of yoga. The observed changes in brain wave patterns, coherence, and synchronisation indicate a state of heightened relaxation, higher cognitive performance, and improved emotional well-being.[6] As more study is conducted in this domain, it is probable that we will acquire a more profound comprehension of the complicated mechanisms via which yoga impacts brain activity and contributes to general mental well-being. [7]

ARDHA CHAKRASANA:

Place your palms on your waist, facing your fingers forward while supporting the waist. Try to bend backwards as far as possible with the support of your waist. Maintain your posture while breathing normally and without losing your balance. This is the position of ardha chakrasana. It is also known as half wheel pose.[8]



Figure 1. ARDHA CHAKRASANA

BHRAMARI PRANAYAMA:

Bhramari pranayama practice is also known as Humming Breath. It is the action of making a light humming sound while practicing pranayama, or yogic breathing. Sit down in vajrasana or padmasana at a peaceful place. The subjects are instructed to stretch shoulders out and spine straight. Then, open palms and close ears with thumbs. Place index finger on the forehead, right above the eyebrows. Let middle and ring finger rest on closed eyes. Breathe in deeply and exhale slowly, keeping mouth closed. While breathing out, make a little humming sound. Finger should feel the vibrations of the sound. Remove the fingers gently from the face and rest them on knees. Repeat the procedure for 5-10 times. [9] Bhramari Pranayama Calms and quiets the mind, releases cerebral tension and stimulates the pineal and pituitary glands, supporting their proper functioning.[10]

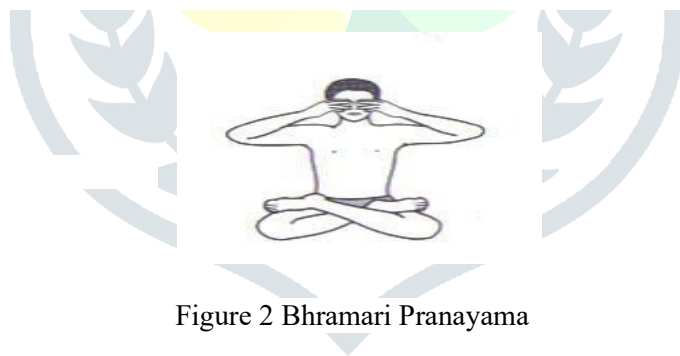


Figure 2 Bhramari Pranayama

NAUKASANA:

Naukasana in a supine pose is performed by facing upwards and lying on the back. The body should be balanced on the tripod of the seated bone and tailbone. [11]The legs and thighs should be maintained at a 45-degree angle above the floor with the knees are straight in the air. The head should be straight up and your hands should be grabbing toes.

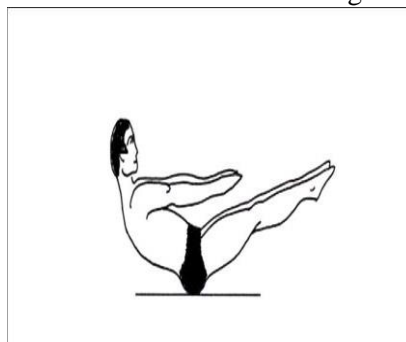


Figure 3. Naukasana

3. MATERIALS AND METHODS:

3.1 DATA ACQUISITION AND PROCESSING:

ECG and EEG were recorded simultaneously using BIOPAC MP150 system.

ECG signal was recorded using five electrodes connected to left and right wrists and left and right arms and one electrode at chest. EEG signal was recorded by fixing the CAP100C on the scalp of the subjects. Both ECG and EEG signals were recorded from subjects in sitting position with eyes closed. The baseline signal was saved on the hard disk for offline processing. Both ECG and EEG signals were recorded with a sampling frequency of 512 Hz to have better resolution of R-R time interval series and EEG activity.

3.2 ANALYSIS OF ECG SIGNALS;

The heart rate variability (HRV) is an indicator of cardiac ANS and HR is controlled by neural activity. The yogic exercise particularly pranayama (breathing techniques) activates ANS. The yoga practicing group showed significant increase in HRV ($P < 0.0304$) and reduction in resting HR ($P < 0.0389$). The significant reduction in resting HR indicates a relaxed state of physiology and increased mental alertness. The SDNN which reflects the total power significantly increased ($P < 0.0012$). The RMSSD, an indicator of parasympathetic activity, also increased significantly ($P < 0.0058$).

mHR: mean RR intervals

mHRV: mean heart rate variability and it indicates the total amount of deviations of both instantaneous HR and RR intervals. It reflects sympathetic and parasympathetic activity of the ANS on the sinus node of the heart.

SDNN: standard deviation of all NN intervals and an indicative of global HRV. It indicates all the long term elements and circadian rhythms responsible for variability in the recording interval.

RMSSD: the Square roots of the mean of the sum of the squares of differences between adjacent NN intervals and it reflects the short cyclical variability in the autonomic tone that is largely mediated. [12]

Table 1. Parametric evaluation of health subjects before and after practicing YOGA

PARAMETERS	BEFORE	AFTER	P value
mHRV (ms)	757.21 ± 65.37	813.29 ± 78.91	0.0304
mHR (bpm)	79.79 ± 7.74	74.57 ± 7.05	0.0389
SDNN (ms)	44.43 ± 21.76	52.14 ± 23.27	0.0012
RMSSD (ms)	39.93 ± 23.65	55.21 ± 22.78	0.0058
SDNN/RMSSD	0.77 ± 0.37	1.11 ± 0.57	0.0039

3.3 ANALYSIS OF COGNITIVE PERFORMANCE:

The relative EEG band powers of β , α , and δ increased in yoga group in all the lobes of the brain. The increases of these band powers indicate improvement of certain cognitive functions such as memory, attention, executive functions, and concentration. The increase of δ power and decrease of θ power indicate improvement in neural activity. The total band power (global) of β , α , and δ increased among yoga group. The increased β power was associated with enhanced cognitive performance such as improved alertness. The maximum β power increased in frontal and central lobes of the brain. This indicates the improvement in emotion process and cognition. The increased α and decreased θ powers physiologically signify the enhanced vigilance and increased alertness level of subjects. [13]

3.4 EEG BAND POWERS.

Table 2. Evaluation of EEG band power before and after practicing YOGA

	Before yoga	After yoga
α ($\mu\text{V}^2/\text{Hz}$)	19.76	28.37
β ($\mu\text{V}^2/\text{Hz}$)	11.61	24.55
θ ($\mu\text{V}^2/\text{Hz}$)	106.82	79.42
δ ($\mu\text{V}^2/\text{Hz}$)	21.09	28.94
γ ($\mu\text{V}^2/\text{Hz}$)	19.02	18.24

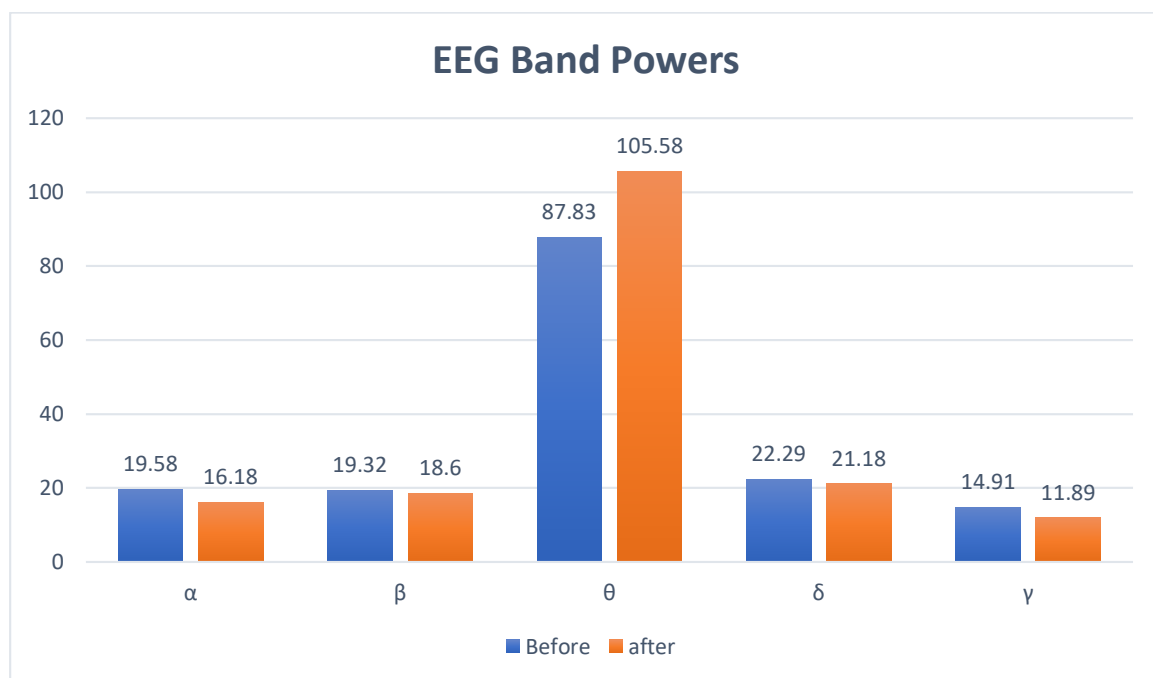


Figure 4. Graphical representation of effect of YOGA on the various factors of EEG

4. RESULT AND DISCUSSION

There will be notable disparities in the alpha brain wave patterns between those who practise yoga and those who do not. Table 4.1 presents a concise overview of the analysis of the mean and standard deviation. Quantification of alpha brain wave activity in a group of female participants, comparing those who do yoga and those who do not. The table displays the mean score and standard deviation for the group of Yoga-Meditation Practitioners, with a mean score of 2583.33 and a standard deviation of 1487.30. The group of Yoga-Meditation Non Practitioners has a mean score of 1646.66 and a standard deviation of 890.80. The data shows that the mean score of alpha brain waves is higher in the group of Yoga-Meditation Practitioners compared to the group of Yoga-Meditation Non Practitioners females.

The alpha state is characterised by a state of relaxation, along with a heightened level of attention and receptiveness. During this state of awareness, an individual experiences tranquilly, enabling them to assimilate novel knowledge and cultivate greater adaptability and receptiveness to fresh opportunities. Alpha waves are linked to the practice of meditation and the experience of tranquilly and serenity. Augmenting the production of alpha waves not only mitigates stress and anxiety but also enhances individuals' ability to sustain concentration. Anxiety is linked to a reduction in alpha brain waves and an increase in beta brain waves.

Consistent engagement in yoga practice and meditation has been scientifically shown to enhance alpha waves, which are associated with relaxation, while simultaneously decreasing beta waves, which are linked to active thinking and learning. Therefore, it is often advised as the most effective method for alleviating stress. The findings confirmed hypothesis no.1, which posited that there would be notable disparities in the Alpha brain waves between those who practise yoga and those who do not. Therefore, the hypothesis is deemed valid.

5. CONCLUSION:

1. The frequency of Alpha brain waves was found to be higher among female practitikaangoners of Yoga-Meditation compared to female non-practitioners during a state of meditation.
2. The frequency of Beta brain waves reduced in female practitioners of Yoga-Meditation compared to female non-practitioners during a state of meditation. Yoga seems to have a beneficial impact on brainwave activity by promoting the activation of alpha brainwaves, which are linked to enhancements in cognitive function, memory, and mood.

Yoga is a comprehensive and transformational discipline that encompasses the many aspects of human life. The advantages of engaging in this activity go much beyond only improving physical fitness, and also include enhancing mental, emotional, and spiritual well-being. Amidst a society characterised by a relentless acceleration of daily activities, yoga provides a refuge—a domain where people may foster equilibrium, fortitude, and a thorough comprehension of their own consciousness. As the awareness of yoga's transforming potential grows, it remains an enduring and indispensable resource in the pursuit of optimum well-being and satisfaction.

6. ADVANTAGES OF PRACTICING YOGA FOR PHYSICAL WELL BEING

The pursuit of comprehensive well-being has become more vital than it has ever been in today's fast-paced world, which is packed with stress, demands, and continual stimulation. The ancient discipline of yoga, which has its roots in India and dates back more than five thousand years, has arisen as a shining example of equilibrium and peace in the more recent era. A comprehensive approach to health, yoga incorporates breath control, meditation, and ethical concepts in addition to its physical postures. Yoga is a practice that embraces holistic wellness. In the following paragraphs, we will discuss the transformational potential of yoga as well as the many advantages that yoga offers to the mind, body, and spirit.

1. One of the benefits to one's physical health is increased flexibility and strength. The focus that yoga places on physical postures, also known as asanas, is one of the most recognisable characteristics of the practice. Through the use of these postures, not only is flexibility improved, but also strength and balance are improved. Regular practice helps to develop total body awareness, as well as tone muscles, increase joint mobility, and increase joint mobility.
2. Enhanced functionality of the respiratory system: Practicing yoga focuses a significant emphasis on pranayama, which is the regulation of one's breath. Individuals may learn to enhance their oxygen intake, improve their respiratory function, and expand their lung capacity via the practice of mindful breathing methods. This has a significant influence on the general vitality and energy levels of the individual.
3. Relaxation Practices and Methods to Reduce Stress: Endorphins are natural mood enhancers, and the practice of yoga stimulates the body's relaxation response, which in turn causes the release of endorphins. As a result, this helps to decrease tension, reduce anxiety, and increase the quality of sleep that someone receives.

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