

Biomechanics of Yoga

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Abstract - "Yoga" is a saàskta term with several meanings, but most often refers to "affixing" or "joining" (an individual consciousness with the supreme consciousness). Sage Patanjali developed this school of thought, one of the six traditional schools of Indian philosophy. Yoga, according to Sage Patanjali, is not a state of oneness but rather a disjunction, a dividing of the spiritual principle from the material principle. It's the world's first comprehensive approach to self-improvement, focusing on the whole person rather than just one aspect. The ancient sages had a deep comprehension of man's inherent nature and the need of living in harmony with one's self and one's surroundings. Yoga is both a science and an art because of this. In this paper the discuss the Biomechanics of yoga.

Keyword - yoga, Biomechanics, Muscles

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INTRODUCTION

Biomechanics

Gravity is an ancient force that all life on Earth must contend with. Gravity, a topic of scientific inquiry for centuries, affects the structure, behavior, and movement of these living systems. The field of biomechanics investigates how forces such as weight, velocity, stress, and strain act on the solids and fluids that make up living organisms. The cellular level, the mechanical properties of soft and hard tissues, and the growth and motion of the body's neuromusculoskeletal system are all influenced by these factors.

Several mechanistic elements can affect how the skeleton looks. Biomechanical and neurological factors interact intricately to produce a wide range of human motion. The kinematics and dynamics of the musculoskeletal system are involved in the biomechanical factors, while sensory motor integration is a function of the central nervous system in the case of the neurological factors. Therefore, motion in humans is the result of the nervous system directing the complex mechanical interaction of the musculoskeletal system's bones, muscles, ligaments, and joints. Biological organisms are in constant motion as a result of the various forces acting upon them. Overstressing tissues can lead to damage, but a healthy stimulus can spur expansion and development.

Static and dynamic stability under gravitational and other loads, as well as regular, precise limb control, are provided by muscles, which generate tensile forces and apply movements at joints with short lever arms. A breakdown in the mechanical interaction between the various parts of the musculoskeletal

system can lead to degeneration, instability, or even the inability to move altogether if even one of those parts is injured or damaged. Injuries can be avoided, abnormalities can be corrected, and recovery times can be reduced with the help of an environment that can be effectively modified, manipulated, and controlled. As a result, biomechanics of human movement knowledge can be applied to boost performance and prevent or treat injury. [1]

Yoga

Yoga is a complicated and age-old discipline with its origins in Indian thought. It was originally a spiritual activity that has gained popularity as a means of improving one's health on all levels.

Traditional yoga incorporates more than only the physical postures (asanas), breathing exercises (pranayama), and meditation that are central to modern Western yoga practice (dyana).

Yoga comes in a wide variety of techniques, some of which are more mild than others. The outcomes of studies may vary depending on the specific styles of yoga used. Since this is the case, assessing studies on the benefits of yoga on health is difficult.

"Meditative movement" methods include yoga and two Chinese traditions, tai chi and qi gong. Physical and meditative components can be found in all three methods.

Health benefits of yoga

1) Better Flexibility

Increased stamina and vitality are just two of the many benefits of practicing yoga regularly. Muscles weaken and joint range of motion decreases as we age. The initial yoga sessions will aid in capability loosening in this regard.

2) Better Posture

The effects of poor posture on the body are more than just aesthetic. Back and neck pain, as well as joint and muscle fatigue, have all been linked to poor posture. Incorporating these changes will help the posture immensely. Each yoga pose is designed to gently realign the body without causing any unnecessary strain. Many yogic postures aim to realign the entire body, from the pelvis to the upper arms to the lower legs.

3) Perfect Balance

You can find your center of gravity through the practice of yoga. Proper material or physical entity governs a human being, and this must be substantiated by spiritual or mental capacity. Only when both the body and the mind are in good shape can a man be considered truly whole. Focus and concentration are required for all yogic postures, from the most basic beginner movements to the most complex advanced stretches. Over time, regular Yoga practice improves focus and attention span, making it easier and more natural to hold these positions for longer periods of time.

4) Lower Blood Pressure

As high blood pressure is a risk factor for cardiovascular disease, including heart attack, stroke, and other complications, it should be closely monitored and treated. Aside from taking medications, there are natural ways to lower high blood pressure. Feeling happy and developing one's potential should be priority number one. Focusing on meditation while holding postures has additional health benefits, including a reduction in blood pressure.

5) Better Circulation

Because of the difficulty of many yoga postures, it is a great way to increase cardiovascular fitness. This means that all cells and organs are receiving oxygenated blood, which improves their performance. Since blood clots are a common cause of heart attacks and strokes, yoga's ability to thin the blood may make these conditions less likely to occur. In addition to the previously mentioned benefits, yoga has also been shown to alleviate hand and foot swelling. Pose variations like the chair, downward dog, and warrior are all great for your cardiovascular health.

Kinds of Yoga

According to the Dattatreya Yoga Shashtra and Yogaraaj Upanishad, there are four Schools of yoga.

1. **Mantra yoga** (Holy incantations or Mantras) The siddhi (powers) of Anima, Garima, etc. are attained after 12 years of ritualized mantra chanting by the seeker.
2. **Laya Yoga:** Laya yoga entails keeping God in mind at all times while going about one's daily activities.
3. **Hatha Yoga:** Hatha yoga is a practice that involves consciously suppressing and controlling the natural tendencies of the mind and body through a variety of postures, breath control, and physical exercises to purify the body and train the mind to focus on a single goal in order to achieve ultimate enlightenment.
4. **Raja yoga:** Raja yoga is the practice of modulating breathing patterns (in and out) through strict control of the body's natural mechanisms in order to achieve a state of spiritual purity and enlightenment (called shamatha in Hinduism) that allows one to attain Moksha, or liberation from the bonds of the physical body and its mind.

Yoga Biomechanics

Yoga biomechanics is a newly developing subfield of biomechanical study. It is the study of how yoga improves quality of life, performance, balance, stability, coordination, flexibility and range of motion, muscular strength and endurance by influencing the interplay of forces and their effects on the body, the shape, function, and motion of our biological body. Asana, Pranayama, and Pratyahara are the foundational pillars of yoga biomechanics.

1. Joint Action - Cartilage, fibrous tissue, synovial fluid, or a combination of these can be used to categorize the structural makeup of the joints. Joints may also be categorized functionally by their range of motion, and biomechanically by the number and complexity of the bones they connect. The amplitude of the joint motion caused by a muscle contraction is also significantly affected by the fibre length. Muscles move our joints by shortening, their most basic behavior. In contrast, the most mobile joints in the body, the synovial ones, are the focus of san's.

2. Skeletal joint action and muscular joint actions

Skeletal joint actions: The major joints that are used to move inside the sana are named by the functions they provide (flexion, extension, adduction, abduction, rotation, etc.).

Muscular joint actions: Concentric action (in which the force generated by the muscle fibers during contraction is greater than the resistance being encountered, resulting in a shortening of the muscle as its ends slide toward one another.), eccentric action (wherein the muscle fibers contract, but produce less force than the resistance, allowing the

muscle's ends to slide apart and the muscle to lengthen.), and isometrial action (where the muscle fibers contract and produce as much force as the resistance, maintaining the muscle's original length) are To achieve a concentric contraction, the muscle must have a pulling power that is higher than the resistance. When a muscle is contracting eccentrically, its pulling power is lower than the resistance, while when a muscle is contracting isometrically, its pulling power is equal to the resistance. Initiating all the skeletal and muscular actions in sequence to provide a wide range of movement is at the heart of the san's practice. An sana's foundational position is defined, and the series of skeletal and muscular actions that culminate in the final sana's form is described.

3. Physiology of stretching - This involves the three methods of stretching:

Ballistic stretching - Putting the muscle length back to where it was before training.

Passive stretching - The stretch receptor is given more time to adjust to the stretch by holding the stretch for a longer period of time.

Facilitated stretching - This stretch requires you to briefly contract the muscle you want to lengthen. Each of these three approaches is integral to the development of san's, and they are often combined in a single session, depending on the practitioner's needs.

4. Reciprocal inhibition - When the agonist muscle contracts, it causes a wave of activity in the antagonist's alpha motor neurons, which in turn causes the agonist muscle to relax, a process known as reciprocal inhibition. Each muscle in a paired system receives a signal when one of them contracts, prompting it to respond and modulate its activity accordingly. At the spinal-cord level, some agonist-antagonist muscle pairs act in relationship, while at the higher brain levels, other pairs of muscles initiate and coordinate repeated movement patterns. Flexion and extension, abduction and adduction, and so on are all examples of the systematic performance of this reciprocal relationship in different san. [2]

5. Breath Awareness - In an āsana, the breathing pattern is illustrated at three levels:

Stage 1 - Inhaling while drawing oneself into an āsana.

Stage 2 - Intentional diaphragmatic breathing in a yoga pose

Stage 3 - Using your exhale to slowly release from a sana. Pranayama classifies and describes breathing in terms of its function, such as for even breathing, diaphragmatic breathing, hyperventilation, or the intentional suspension of breath.

Yoga's healing system is governed by a set of fundamental principles that must be comprehended in order to grasp its biomechanical underpinnings. Individuality, and the fact that each practitioner has specific requirements, is central to Yogic thought. The second source of strength comes from within the practitioner, who is able to promote his own healing through natural means. One's mental state is the final pillar of the principle set forth; a constructive outlook is the key to rapid development.

A Sound Mind

Numerous studies have shown that regular yoga practice alleviates depression by calming the mind and regulating the body's physiological responses to stress. This is because the hypothalamus's posterior is inhibited in response to stress, allowing for more effective responses. Feelings of elation are produced by the activation of pleasure centers in the median brain while the areas of the brain responsible for fear and anger are turned off. In addition, there are no negative side effects from lowering stress thanks to the combination of a rise in serotonin and a fall in the cortisol-breaking enzyme monoamine oxidase. An active brain needs yoga. Consistent meditation has been linked to a thickening of the cerebral cortex and an enlargement of the hippocampus, both of which improve mental function and memory. The amygdalae, which trigger the "fight or flight" response that can lead to stress in unfavorable situations, have been shown to shrink in some research. [3]

In addition to the obvious physical benefits, breathing exercises have been shown to have positive mental effects by increasing brain oxygenation. Shirshasana and other asanas like it increase the flow of oxygen-rich blood to the brain, which in turn stimulates the organ. Practicing yoga has been shown to improve mental health, which is increasingly important in today's society.

Scientists investigating the biomechanics of yoga have conducted numerous experiments. The findings of which have contributed to Yoga's growing reputation in the scientific community.

A Sound Body

Researchers observed that regular practice loosened the muscles and tissues around the bones and joints, leading to greater mobility. In addition, the mobility of cartilage results in a new supply of blood, nutrients, and oxygen being sent to the joint region, which is beneficial for just about every position. It's useful in alleviating the symptoms of diseases like arthritis.

Inverted positions enable oxygenated blood to flow into the legs, while twisting poses force venous blood out of internal organs. Aerobic yoga is a popular practice because it promotes oxygen intake

and usage, which in turn reduces resting heart rate and improves stamina and endurance.

There is no part of the body that asanas don't work on. Asanas, or yoga postures, are a great way to increase both of these benefits. Padmasana, a basic asana, extends the hamstring muscles and ligaments, which in turn increases ankle mobility. Each variation of Virabhadrasana focuses on the hamstrings while the knees remain bent. Strong, mobile joints are a result of regular exercise.

However, by placing a load on the wrists and arms in asanas like Bakasana and Mayurasana, these muscles and bones are strengthened. Both Dhanurasana and Chakrasana lengthen the hamstrings and buttocks by engaging the adductor muscles and applying pressure to the gluteus maximus. Simultaneously, the spine lengthens. Trikonasana, in any of its many variations, is a rotatory exercise that stretches the thoracic spine.

Yoga practice increases spinal mobility, increases joint mobility, and improves overall body flexibility. The result is improved stamina and muscular strength.

The Union

In addition to requiring physical exertion that improves balance or mental meditation that soothes the mind, yoga also includes balancing poses. Savasana, the last relaxation position of a yoga practice, and the breathing techniques of pranayama and pratyahara, which allow the respiratory and neurological systems to rest, are all instances of restorative yoga postures.

The cardiovascular and pulmonary systems have both been found to benefit from regular Yoga practice, including reduced blood pressure. Insomnia is overcome and sleep cycles are normalized when there is harmony between the body and the mind. [4]

Yoga, a practice with ancient roots in India, is revolutionizing modern society. More than 300 million individuals worldwide regularly practice yoga, according to the International Yoga Federation. The number of researchers studying yoga for medical benefits is also increasing. As more and more people find inner calm via Yoga's teachings, we can confidently claim that its heritage is being kept alive and will continue to thrive.

DIFFERENT TYPE OF JOINT

MUSCLE [5]

- The human body has about 640 muscles.
- Muscle tissue comes in three different varieties: cardiac, smooth, and skeletal.
- Skeletal muscles are joined to bones, which permits movement of the body.

- Skeletal muscles contract and move the joints as a result.
- The skeletal muscles in an asana control the movement of the joints.

GROUP ACTION OF MUSCLES[6]

- **Agonists:** a group of muscles that contract to generate the movement's necessary force.
- **Antagonists:** These muscles fight the agonists' effects and gradually relax to allow movement.
- **Synergists:** These muscle groups cooperate with agonists to produce an appropriate activity that facilitates movement.
- **Fixators:** These muscles increase the agonists' ability to produce movement by stabilizing the agonists' cranial bones of origin.

STRETCHING [7]

- **Cyclic stretching:** a comparatively brief stretch force that is repeatedly but gradually applied, released, and then reapplied
- **Ballistic stretching:** a swift, forceful, intermittent stretch, or one that is both fast and intense.
- **Mechanical stretching:** equipment for joint ROM expansion and stretching.
- **Manual stretching:** A small amount of external force is used by the therapist to move the affected body segment past the point of tissue resistance and its range of motion (ROM).
- **Neuromuscular inhibition techniques:** Prior to or during stretching, these procedures reflexively release tension in shortened muscles.

POSTURES [8]

- Posture is the attitude that the body adopts.
- There are two types of postures: active and inactive.

There are basically three categories of postures in Yoga

- **Cultural:** for physical fitness, especially by activating and deactivating various muscle groups
- **Relaxing:** before and after cultural postures, for relaxation
- **Meditative:** for meditation (mental fitness), generally sitting and stable

BIOMECHANICS OF MUSCLES [9]

All movements are shaped by force of gravity.

In **Padahastasana:**

- The erector spinae, gluteus, and hamstrings are extensors, not flexors, of the hip joint.
- By letting go of gravity to control downward movement, they work to bend the hip.
- The hip extensors and erectors are lengthening during the contraction.

In **VirabharadrasanaII:**

- A stabilized but partially bent knee
- The antagonist's release rate must match that of the agonist's contraction rate.

BIOMECHANICS OF VERTEBRAL COLUMN[10]

- It is known as a kinetic chain in biomechanics.
- Both movement and stability are intended.
- In each vertebra, a tripod stool provides stability..
- The most stability is created by maintaining the natural curve in vertical poses like Tadasana and sitting in Siddhasana.
- Intervertebral discs control the range of motion of each vertebral segment.
- The angle of the facet joints determines the movement's direction.

REVIEW OF LITERATURE

Telles and others (2018) to research how border security force (BSF) employees performed in a vigilance test and how well they slept after practicing yoga for nine days. Participants in the experiment were 722 BSF members. Their average age was 30.9 7.4 years, and they were all men. They were all tasked with policing the nation's border. They were sent for a nine-day residential yoga instruction program. They were evaluated for self-rated sleep, state anxiety, and attentiveness both before and after training.

RESULTS: The findings point to yoga's advantages for BSF troops. The alertness test results of BSF staff significantly improved, while state anxiety decreased and self-reported sleep quality increased.[11]

Shaikh (2013) One of the six orthodox Indian philosophical systems is yoga. Man becomes a Yukta—one in communion—when mind, intellect, and self are in check, freed from restless desire, and allowed to rest in the spirit within. Yoga is a discipline that is systematic and was developed for self-realization in India. One may choose a single asana or a variety of asanas. It might be uncomfortable at first while you're learning because anything new is uncomfortable at first, but after some practice, it gets easier. The study's goal is to help college-age female students' physical fitness levels through yoga. It was predicted that yogic exercise would be superior to all other interventions in terms of improving physical fitness. [12]

Rejinadevi and Ramesh (2017) The purpose of this study was to investigate the effects of yoga on several physiological variables in elite basketball players. A total of 40 male basketball players between the ages of 18 and 25 were selected at random from S.V.N College and Arul Anandar College in Madurai, Tamil Nadu, for the study. A total of forty persons, split into two groups of twenty, will take part. Yogic techniques (Group I) were compared to conventional care (Group II). The experimental group participated in a Yogic practices course for twelve weeks, in addition to their regular college coursework. Those in the "control" group did not engage in any additional training beyond their typical routines. The systolic and diastolic blood pressures were measured using a sphygmomanometer, which is the criteria. We performed analysis of covariance (ANCOVA) with a 5% significance level to compare the two groups statistically. After completing 12 weeks of yogic practices, the experimental group showed considerable improvement on chosen measures compared to the control group. [13]

Nathiya and Ramesh (2016) The researchers wanted to see how yoga practices affected many physiological factors in the lives of overweight schoolboys. Thirty overweight schoolboys, aged 11 to 15, were chosen at random from the Madurai area in Tamil Nadu for the purpose of this research. Fifteen overweight schoolboys were split into two groups at random. The research protocol included a pretest and a posttest, making it a genuine random group design. Both the yoga practice group and the control group were given the same starting conditions. The training was administered to the experimental group for 12 weeks to determine the effectiveness of the training packages, while the control group received no training. The paired t-test methodology was used. In all cases 0.05 level of confidence was fixed to test hypotheses. After twelve weeks of yoga practices, the group of overweight

school boys showed considerable improvement in all the specified physiological measures. [14]

Gallwey, (2008) There are good and bad ways to judge an athlete's performance. The cycle of reflection and self-aware behavior is maintained by these kinds of assessments. A player's muscles tighten and their agility decreases as a direct result of receiving negative feedback. In addition to agility, strength, and power, the ability to quiet the mind's chatter is increasingly important for any athlete seeking to achieve a state of flow.[15]

Telles et. al. (2013) conducted a randomized controlled trial comparing the effects of yoga and conventional exercise on children's health. The physical, mental, and emotional benefits of exercise and yoga in children have been reported in numerous studies. In this randomized controlled trial, researchers compared the effects of yoga and traditional exercise on students' fitness, brainpower, confidence, and academic performance as evaluated by their teachers. A total of 98 students ages 8-13 were split evenly (n = 49) between yoga and physical exercise groups. The yoga group included 15 female students (mean age 10.4 1.2 years), while the physical exercise group included 23 female students (mean age 10.5 1.3 years). After random assignment, both sets of kids were tested blindly using (i) a battery of fitness tests called Eurofit, (ii) a Stroop color-word task designed for kids, (iii) a self-esteem survey called Battle's, and (iv) teacher ratings of the kids' obedience, academic performance, attention, punctuality, and behavior with classmates and teachers.[16]

Vijayalakshmi & Jayobal3 (2013) compared the effects on certain physical and physiological variables in adolescent boys of engaging in a combination of own-body resistance exercises and plyometric with and without yogic practices. This study aimed to examine the differences between the physiological and physical outcomes for teenage males who performed a mix of own-body resistance exercises and plyometrics with and without yogic practices. Sixty males, ages 13 to 18, were chosen at random and placed into one of three groups for a twelve-week training period. Subjects' resting heart rates, breathing rates, and reactivity were measured before and after training. The analysis was performed using ANOVA for statistical significance. The findings revealed that the experimental groups significantly outperformed the control group in terms of agility, flexibility, and resting heart rate. After 12 weeks of training, the experimental groups showed improvements in agility, flexibility, and resting pulse rate, while the control group showed no significant changes.[17]

Gauri Shankar et. al.5(2011) I have tested the impact of Suryanamaskar Yoga on healthy adults' cardiovascular performance, range of motion, and muscular endurance in the upper body. The goal of this research is to determine whether or not regularly practicing Suryanamaskar yoga can help less-active

adult males and females improve their resting heart rate (HR), blood pressure (BP), flexibility, and upper body muscle endurance. Methods: For this study, researchers at Sumandeep Vidyapeeth University randomly assigned 80 normal, healthy students (40 males and 40 females) aged 18 to 40 years to either a yoga or control group. Subjects were taught Suryanamaskar for 1.5 hours and then instructed to practice two routines per day for 105 days. Suryanamaskar yoga is practiced for two minutes at a time, followed by a five-minute rest period, for a total of fourteen times over the course of two weeks, as described in Gauri Shankar and Bhavita Pancholi's "Suryanamaskar Yoga's Impact on Healthy Adults' Resting Heart Rate, Blood Pressure, Range of Motion, and Upper-Body Muscle Endurance".[18]

CONCLUSION

In this research, we systematically measured the load placed on the lower limbs by five popular standing yoga asanas, and we utilized those results to provide recommendations on how to best include strength training into the treatment of a variety of musculoskeletal disorders. Due to its beneficial effects on quadriceps strength and knee adduction moment reduction, our research suggests that the Chair position is the superior option for knee OA patients. Chondromalacia patellae patients should use Warrior 1 because of its greater strengthening benefits on VM. Because Warrior 2 requires a great deal of external rotation of the hips, it may be unsafe for patients with hip osteoporosis. Due to their massive hip JMOFs, neither Warrior 1 nor 2 are appropriate for individuals with hip OA. Our findings also indicate that Warrior 3 is the best option among these five asanas for the rehabilitation of patients with recurring hamstring strains, suggesting that it has favorable benefits on hamstring training. Those older yoga practitioners who have trouble maintaining their balance while standing might try practicing the Tree pose adjacent to a wall or a chair. If you have ankle cartilage degeneration, you should be careful while choosing yoga poses that put too much weight on one foot. It's a great option for the aforementioned use scenarios, and it's also great for newcomers learning to stand on one foot.

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