CHAPTER 20

Effects of Yoga on Mental and Physical Health Outcomes

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Key Concepts

- Chronic stress leads to overactivation of physiological systems, taxing the body causing fatigue, negative mood, and complex systems within the body to adapt, often becoming dysregulated.
- Stress is linked to the development of 2 out of the top 3 causes of death worldwide and leads to poorer prognosis and management of chronic diseases as well as quality of life following diagnosis.
- Yoga has been used for centuries to strengthen mind, body, and spirit.
- Yoga involves physical movement synchronized with breath and supports a mindful approach to life.
- Yoga appears to be a stress reducing behavior that leads to better physical and mental health outcomes.
- Yoga interventions in multiple clinical populations have resulted in improved physical and mental health outcomes in the yoga groups compared to wait-listed, education only, or active control groups.
- Reliably, yoga practice has led to elevated mood, reductions in fatigue, improved cardiovascular functioning as well as diminished inflammatory activity.
- Theoretical mechanisms for yoga's benefits are abundant; however, the research elucidating the precise mechanism(s) is in its infancy.

INTRODUCTION

Since the advent of modern medicine, the causes of morbidity and mortality have evolved from acquiring infectious diseases to the development of non-communicable diseases. Today, 9 of the top 10 causes linked to death globally are chronic illnesses that stress is a risk factor for either disease pathogenesis or poorer disease prognosis.

The body's stress systems evolved to protect us from danger and survive life-threatening situations. When stress is perceived, the sympathetic nervous system (SNS) and hypothalamic-pituitary-adrenal (HPA) axis activate and flood the blood stream with hormones that stimulate glucose release, increase heart rate, blood pressure, and breathing rate, and heighten sensory and mental processing to support an engage or retreat response from the current situation. Thus, it is adaptive in the short term. Chronic stress, however, can take a serious physiological toll on the body.

Constant presence of epinephrine and norepinephrine (SNS hormones) as well as cortisol (HPA axis end-product) and parasympathetic nervous system (PNS) withdrawal leads to wear-and-tear as the body continually adapts to stress and can result in dysregulation. One potentially dysregulated system is the immune system; SNS and HPA axis hormones directly impact immune cell function, and chronic exposure diminishes immune cells' sensitivity to these hormones. In other words, immune cells can become resistant or insensitive to the hormones. This dysregulation may lead to chronic disease development and drive additional system imbalances also known as multimorbidity.

To aid in prevention or further development of stress-related illnesses, behavioral factors beyond medication are being examined as ways to diminish the effects of chronic stress on the body. In the long-term, decreasing stress system activation or altering stress perceptions may yield reductions in chronic disease development and/or assist in disease management. One such stress management behavior includes the practice of yoga.

YOGA

Yoga, from the Sanskrit root "yuj" means to yoke, or unite, through integration of the physical body, mind, and spiritual soul to face life with awareness and harmony. Originating as part of Hinduism in India at least 5,000 years ago, it has long been thought to improve physical health and well-being. Yoga has an integrative nature and consists of eight "limbs": integrity and ethical standards (Yama); spiritual observance and self-discipline (Niyama); physical exercises or postures (Asana); controlled breathing techniques (Pranayama); drawing away from external sensory perceptions to allow for introspection and self-awareness (Pratyahara); concentration on a specific object, idea, or feeling (e.g., the breath) (Dharana); meditating without focus, such that the mind has been quieted and produces few or no thoughts (Dhyana); and the experience of enlightenment and feeling of complete peace (Samadhi). As practitioners develop and adapt to the yogic lifestyle, their experience may encompass all limbs. However, most teachings and research in the Western world focus on 3 limbs: physical postures, controlled breathing, and some form of meditation or concentration.

Hatha yoga's popularity in Western fitness began in the 1960's. Since then, additional styles have emerged, such as Iyengar, Vinyasa, Bikram, Isha, Jivamukti, Yin, Ashtanga, Restorative, and Power yoga (along with many others); each emphasizing particular aspects of yogic practice. For example, Isha yoga places priority on meditation and spirituality, whereas Power yoga was developed as a vigorous, Americanized workout that typically incorporates little to no spirituality or philosophical teachings. Today, the term "Hatha yoga," although technically an umbrella term for most yoga practices, has now morphed into a style involving slow, gentle movements, making it most appropriate for beginners.

Anecdotal evidence for yoga's psychological and physical health benefits is widespread and ancient, declared in text as early as 500 BCE in the Bhagavad Gita. In recent decades, health researchers and physicians have begun to replicate these claims scientifically in experimentally designed studies, including randomized controlled trials.

EFFECTS IN THE GENERAL POPULATION

Psychologically, positive mood effects have been reported with a variety of yogic styles; Iyengar, Kundalini, and Bikram yoga have all been

associated with lower levels of perceived stress, anxiety, and depression in the general population, even when compared to other forms of exercise. For example, when comparing Iyengar yoga with walking, yoga elicited greater improvements in anxiety and mood levels than metabolically-matched walking. These mood alterations were associated with higher gamma-aminobutyric acid (GABA) levels post-practice, pointing to changes in neurobiology as a possible mechanism for greater feelings of well-being after practicing yoga.

In addition, more yoga experience appears to reduce systemic inflammation and attenuate the inflammatory response to stress. Among healthy participants, those who regularly practice yoga typically had lower basal tumor necrosis factor-alpha (TNF-α) and interleukin-6 (IL-6) levels, and were less likely to have detectable C-reactive protein (CRP) levels compared to novice yoga practitioners. Furthermore, in response to an acute stressor, the expert yoga group produced less IL-6 compared to the yoga novices, suggesting that yoga practice is not only related to diminished basal systemic inflammation, but also minimizes inflammatory stress reactivity. These beneficial findings in the general population naturally led investigators to examine yoga as a behavioral intervention to enhance health and well-being among clinical populations.

Effects on Mood and Anxiety

Yoga's stress reduction effects have been similarly demonstrated in individuals who meet clinical standards for depression and anxiety disorders, such as Posttraumatic Stress Disorder (PTSD). Hatha yoga, Yoga Nidra, and restorative yoga interventions are primarily used in these populations to calm the mind and body, resulting in decreased depression or anxiety symptoms. Additionally, in an effort to tailor yoga specifically to individuals afflicted with PTSD, a new style was developed: Trauma-sensitive yoga. It has successfully lowered PTSD symptoms and appears to ameliorate stress via reductions in depression- and anxiety-related symptoms. Furthermore, the reduction of PTSD symptoms, such as intrusive thoughts and rumination involving the traumatic event, may be due to the promotion of mindfulness and living in the present moment.

Reductions in subjective stress via yoga may in turn influence objective stress biomarkers. Acutely, yoga practice appears to reduce cortisol levels even after one session. Unfortunately, yoga interventions have not reliably affected the diurnal rhythm of cortisol (e.g., waking, bedtime, or evening levels), as results are mixed in the current published literature. In addition, no published data exist on whether yoga interventions that ameliorate subjective stress actually translate to reduced cortisol reactivity to an acute stressor. Thus, more methodologically rigorous studies must be designed to investigate the relationship between more yoga practice and optimal cortisol release across the day and/or to a stressor.

Effects in patients with cardiovascular disease

Cardiovascular disease (CVD) is the top cause of morbidity for men and women worldwide. Moderate aerobic exercise beneficially impacts the heart and can lessen future CVD complications. However, patients who have experienced myocardial infarctions or who find it difficult to perform aerobic activity may benefit from an alternate technique that can be modified and tailored to their individual ability level, such as yoga. Furthermore, with stress as a known factor in the development and prognosis of CVD-related diseases, yoga may be an advantageous route to reduce the effects of stress on the cardiovascular system and prevent progression of, or even reverse, the disease.

Long-term effects of yoga on heart health include significantly fewer heart disease complications, such as fewer incidences of ischemic heart disease, reductions in left ventricular mass, myocardial infarctions, and less medication needed to control hypertension compared to drug treatment-only groups. Additionally, yoga interventions have repeatedly shown moderate, but clinically meaningful, reductions in both systolic and diastolic blood pressure among adults with hypertension. These effects tend to be stronger when the intervention includes postures, meditation, and controlled breathing, suggesting the culmination of all three as the most promising technique to improve heart health.

Improved cardiovascular reactivity has also occurred after yoga practice. Indeed, participants had significantly lower heart rate and blood pressure responses during exercise and exhibited faster recovery from exercise after two months of

yoga training, suggesting that yoga improved cardiac autonomic balance as well as enhanced autonomic nervous system flexibility or heart rate variability. Heart rate variability, a predictor of heart disease and all-cause mortality, increased with yoga practice; this positive relationship has been found across multiple types of yoga.

Furthermore, yoga practice delayed disease progression in individuals with severe coronary atherosclerosis and improved blood biomarkers levels. In patients with ischemic heart disease, yoga reduced LDL and total serum cholesterol, as well as the need to take statin drugs. Restorative yoga also significantly reduced inflammation, including IL-6 and CRP, better than standard medical therapy in patients with chronic heart failure. However, most cardiovascular–focused studies included yoga in combination with other therapies and stress management tools, introducing possible confounds into the studies.

Effects in Cancer Survivors

Early detection and more effective drug therapies to treat a variety of cancers has led to an increase in the population of cancer survivors, making it one of the largest growing unique patient populations that medical and health professionals care for on a regular basis. Cancer treatment (e.g., surgery, radiation, chemotherapy, or any combination of the 3) wreaks havoc on the patient's body and brain during treatment that does not always resolve after acute exposure to treatment. Persistent conditions that diminish quality of life following cancer treatment include fatigue, cognitive impairments, loss of mobility, depression, anxiety, and changes in employment, income, and social networks can compound an already stressful situation. Thus, controlling or minimizing stress following diagnosis, during and after treatment is critical to improving quality of life.

In breast cancer survivors, yoga interventions enhance mood and reduce fatigue during and following treatment; these results have been replicated in multiple studies, positing yoga as a reliable stress reduction technique in cancer survivors. Furthermore, cognitive impairment decreased following a yoga randomized controlled trial (RCT) in those who received the yoga training compared to the wait-listed group. Of note, this benefit was not detected immediately following the 12-week intervention, but appeared at the 3-month follow-up.

Cancer treatment dramatically elevates systemic inflammation and may drive negative mood, cancer-related fatigue, and poorer quality of life. Indeed, in a RCT with 200 breast cancer survivors, women in the yoga group showed reduced cytokine (i.e., IL-6, TNF-a, and IL-1beta) production to mitogenic stimulation at the 3-month follow-up than women who were wait-listed. This reduction in immune reactivity was also dose-dependent; those who practice more yoga had greater reductions in cytokine production compared to their less yoga-active counterparts. These inflammatory changes mirrored improvements in fatigue and vitality.

Possible Underlying Mechanisms

Yoga's effects on health may be due to improvements in mental health that then have a cascading effect on physiological systems. For example, yoga classes, particularly if they are more advanced, attempt to maintain a nonjudgmental environment and encourage practitioners to increase positive attitudes toward stress and pain, as well as self-awareness, appraisal of control, calmness, spirituality, and mindfulness. Yoga also places value on self-regulation of emotions and coping with stress through awareness, acceptance and self-compassion. Thus, altering perceptions of stress and strengthening coping skills may be mechanisms through which yoga produces mental and physical health benefits beyond exercise or controlled breathing alone. Although research is sparse linking an enhanced psychological state (i.e., diminished stress reactivity and better stress coping) with physiological improvements, yoga practice generally leads to salutary physiological alterations.

Yoga's mood enhancement and anxiolytic effects may be the result of several physiological pathways. Deep, rhythmic breathing and meditation support PNS activation, promoting relaxation throughout the body. Moreover, neurobiological evidence bolsters its anxiolytic effects; yoga increases neuroactivity of GABA, an inhibitory neurotransmitter that is often targeted by anti-anxiety pharmacotherapy. Additionally, physiological changes may be further impacted by psychological changes during yoga practice. The attenuation of stress and anxiety from practicing

yoga has cascading effects on the peripheral nervous system and the rest of the body, serving as a probable cause of yoga's health benefits.

When a healthy individual perceives stress, the SNS activates and the PNS withdraws. However, during chronic stress, the temporary withdrawal of PNS becomes the new "normal." Cardiac autonomic balance shifts to sympathetic dominance, resulting in elevated heart rate, decreased heart rate variability, and heightened risk of elevated blood pressure. Yoga practice has reliably led to reductions in blood pressure and heart rate, better cardiovascular recovery following exercise, and appears to enhance markers of PNS activation. Furthermore, inversion yoga poses re-sensitized the baroreceptor reflex, a pathway underlying blood pressure reduction. Hence, yoga can normalize cardiac autonomic balance, minimizing stress' detrimental effects and improving cardiovascular health.

Chronic stress also leads to excessive cortisol production via HPA axis activity. Elevated GABA levels in the brain and improvement of the cardiac autonomic balance associated with yoga practice should hypothetically be linked to normalization of the cortisol's diurnal rhythm and diminished cortisol reactivity to acute stress. Unfortunately, current data do not support yoga's effect on overall HPA axis function (i.e., diurnal rhythm or acute stress reactivity) due to extremely small sample sizes or study designs that are not primarily focused with assessing it, making conclusions about the relationship between yoga and HPA axis function difficult. Yet, yoga does appear to reduce cortisol across the class session. Thus, future research should utilize methodologically sound and well-controlled studies to elucidate yoga's effect on cortisol's diurnal rhythm and acute stress reactivity.

Yoga's anti-inflammatory effect has been demonstrated in a wide range of populations, including healthy individuals and clinical populations. The anti-inflammatory cellular mechanisms have been recently elucidated with promising results. Among 31 breast cancer survivors in a RCT, the yoga group (N=16) maintained similar levels of systemic soluble TNF-receptor type II (sTNF-RII), whereas sTNF-RII levels increased in the health education (active control; N=15) group. This difference appeared to be driven by three related factors: 1) reduction in nuclear factor kappa B (NF-kB), an inducer of proinflammatory gene expression, 2) increase in glucocorticoid receptor (GR) expression, and 3) diminished activity of the cAMP-response element binding (CREB) transcription factors. Thus, early evidence points to yoga modulating inflammation via re-sensitization of the GR and two associated inflammatory pathways being down-regulated. These data may support yoga improving HPA axis function; as GRs' sensitivity would most likely improve when immune cells are not exposed to excessive cortisol levels. Furthermore, PNS activation is related to stimulation of the anti-inflammatory cholinergic pathway; acetylcholine via the alpha 7 nicotinic acetylcholinergic receptor can inhibit NF-kB activation. Although promising, these intracellular results need to be replicated in larger samples as well as other clinical and non-clinical populations.

Taken together, yoga has multiple mental and physical health benefits. Yoga diminishes depression, anxiety, and fatigue, resulting in increased positive mood. Stress reduction benefits may be due to yogic philosophical teaching, activation of the PNS, and/or anti-inflammatory factors. Physiologically, yoga reduces heart rate and blood pressure, improves cardiac autonomic balance, enhances PNS activity, acutely attenuates cortisol release, and lowers basal inflammation and the inflammatory stress response.

LIMITATIONS

Yoga has a unique strength as it integrates multiple behavioral concepts such as exercise, controlled breathing, meditation, and relaxation—an ensemble that produces substantial health improvements. It may further attenuate stress through its philosophical teachings in a therapeutic-like environment which stimulate reductions in perceived stress and encourages healthy stress management. However, yoga's integrative nature constrains research attempting to determine the specific mechanism(s) involved. In particular, few studies have focused on one aspect of yoga at a time to delineate effects among possible mechanisms (e.g., the increase of physical activity versus isometric exercise versus PNS activation). More research focusing on these areas separately could reveal the most potent underlying yogic process(es) that confer health benefits.

Within yoga research, there is also a gap regarding yogic philosophy. Philosophical teachings during class may boost health through reductions in stress; spirituality, self-compassion, and acceptance are essential in yogic philosophy. These factors have all been separately associated with lower levels of stress. However, in Western cultures, the focus on these philosophies in studies have been attenuated out of concern that participants may reject spiritual teachings due to their personal religious beliefs. Thus, research emphasizing the inclusion of philosophical teachings should be conducted to elucidate the role of philosophical teachings in yoga's effects on health.

Yoga is an umbrella term for a wide variety of practices. Specifically, intensities and kinds of poses, speed of the flow through the postures, specific breathing techniques, emphasis on and forms of mediation and relaxation, and degree of spiritual guidance given during the practice vary significantly from one style or teacher to the next. Even differences in the temperature of the room (e.g., Bikram at 104°F versus Vinyasa at 80°F) could produce deviations in biomarkers and health outcomes. Likewise, because yoga classes and teaching styles can fluctuate greatly, the level of yogic intensity should be illustrated clearly via greater transparency in protocol description, examination of differences across yoga instructors, and implementation of yoga's philosophical teachings. Future research should investigate whether differences in yoga type modify the cardiovascular health, inflammation, and psychological well-being observed effects. This information could shed light on the most appropriate styles of yoga for reaching individuals' particular health goals given their background.

Conclusions

Yoga practice confers numerous positive effects on health and well-being. Present data support yoga's anxiolytic and stress reduction effects, improvements in cardio autonomic balance, blood pressure and heart rate, and parasympathetic nervous system activity as well as reduced inflammation. Moving forward, it is necessary to tease apart the mechanisms (e.g., relaxation, meditation, exercise, etc.) at play and continue to seek the root causes of yoga's established health benefits.

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