Review Article

Sudarshan kriya yoga: Breathing for health

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ABSTRACT

Breathing techniques are regularly recommended for relaxation, stress management, control of psychophysiological states, and to improve organ function. Yogic breathing, defined as a manipulation of breath movement, has been shown to positively affect immune function, autonomic nervous system imbalances, and psychological or stress-related disorders. The aim of this study was to assess and provide a comprehensive review of the physiological mechanisms, the mind–body connection, and the benefits of Sudarshan Kriya Yoga (SKY) in a wide range of clinical conditions. Various online databases searched were Medline, Psychinfo, EMBASE, and Google Scholar. All the results were carefully screened and articles on SKY were selected. The references from these articles were checked to find any other potentially relevant articles. SKY, a unique yogic breathing practice, involves several types of cyclical breathing patterns, ranging from slow and calming to rapid and stimulating. There is mounting evidence to suggest that SKY can be a beneficial, low-risk, low-cost adjunct to the treatment of stress, anxiety, post-traumatic stress disorder, depression, stress-related medical illnesses, substance abuse, and rehabilitation of criminal offenders.

Key words: Depression; pranayama; stress; sudarshan kriya yoga; vagus nerve stimulation; yogic breathing.

INTRODUCTION

The environmental pollution, increased pace of life, psychosocial disturbances, eating habits, and sedentary lifestyle have increased stress levels and their related disorders.[1] Yoga, an ancient Indian science, has been practised as a healthy way of life. Recently, yoga has been adopted as an approach to health within alternative medicine.[2] Relaxation exercises aim at reducing stress, and thereby help prevent these unwanted outcomes. One of the widely used relaxation practices is yoga and yogic breathing exercises. Yogic breathing, Pranayama, is a unique method for balancing the autonomic nervous system and influencing psychological and stress-related disorders.[3] One specific form of these breathing exercises is Sudarshan Kriya Yoga (SKY) which is shown to have favorable effects on the mind–body system.

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SUDARSHAN KRIYA YOGA

Sudarshan kriya yoga (SKY) is a type of cyclical controlled breathing practice with roots in traditional yoga that provides relief for depression, and it is taught by the nonprofit Art of Living Foundation. It has four distinct components.[4]

Detailed descriptions of the four main SKY breathing techniques are as follows.[5]

1. Ujjayi or "Victorious Breath": This involves experiencing the conscious sensation of the breath touching the throat. This slow breath technique (2–4 breaths per minute) increases airway resistance during inspiration and expiration and controls airflow so that each phase of the breath cycle can be prolonged to an exact count. The subjective experience is physical and mental calmness with alertness.
2. During Bhastrika or "Bellows Breath," air is rapidly inhaled and forcefully exhaled at a rate of 30 breaths per minute. It causes excitation followed by calmness.
3. "Om" is chanted three times with very prolonged expiration.
4. Sudarshan Kriya which is a Sanskrit term meaning "proper vision by purifying action" is an advanced form of rhythmic, cyclical breathing with slow, medium, and fast cycles.

SKY has been taught by the Art of Living Foundation to more than 6 million people in 152 countries worldwide. Possible mechanisms, effects, and benefits of SKY are given below.

INFLUENCE OF SKY ON PHYSIOLOGICAL FUNCTIONS

Neurophysiological model of vagus nerve stimulation pathways

SKY consists of a specific sequence of varying breathing rates separated by brief periods of normal breathing. Strained breathing occurs in nature when an animal is defeated in battle.[6,7] It inhibits activity, increases brain perfusion, increases attention and vigilance (via vagal afferents), slows heart rate, restores energy, prevents hypoxia/hypercapnia,[8,9] and prepares the animal to protect itself.

Many studies demonstrate the effects of yogic breathing on brain function and physiologic parameters, but the mechanisms have not been clarified. Biological postulations from neurophysiological model of vagus nerve stimulation of yogic breathing propose that SKY causes vagus nerve stimulation (VNS) and exerts numerous autonomic effects including changes in heart rate, improved cognition in Alzheimer's disease, improved bowel function, etc. During SKY, a sequence of breathing techniques of different frequencies, intensities, lengths, and with end-inspiratory and end-expiratory holds creates varied stimuli from multiple visceral afferents, sensory receptors, and baroreceptors.[3] These probably influence diverse fiber group within vagus nerves, which in turn induces physiologic changes in organs, glands, and ascending fibers to thalamic generators, the limbic system, and cortical areas. This may account for rapidity and diversity of SKY effects like experience of calmness and relaxation combined with increased vigilance and attention[3,5,6] (for a detailed description of proposed neurophysiological pathways, see Brown and Gerbarg).[3]

Sudarshan Kriya may work like mechanical hyperventilation and electronic unilateral VNS which lead to stimulation of thalamic nuclei resulting in quieting of frontal cerebral cortex.[6]

The Ujjayi practice makes the practitioner feel calm. The proposed mechanism would be a shift to parasympathetic dominance via vagal stimulation. Respiratory sinus arrhythmia (RSA) refers to normal heart rate increases during inspiration and heart rate decreases during expiration. RSA is influenced by sympathetic and vagal (parasympathetic) input, and by respiratory rate and volume. Slow yoga breathing induces oscillations of blood pressure and exaggeration of the normal RSA. Low RSA is usually found in individuals with depression, anxiety, panic disorder, and functional dyspepsia. Ujjayi breath increases RSA by increasing parasympathetic influences.[5]

Bhastrika causes autonomic sympathetic activation and CNS excitation on electroencephalogram (EEG),[10,11] with activation of temporo-parietal cortical areas, producing rhythms that are similar to the gamma frequency bands hypothesized to reflect synchronization of neural assemblies.[12] The subjective experience is of excitation during Bhastrika, followed by emotional calming with mental activation and alertness. The daily practice of Bhastrika provides a mild sympathetic stimulation much like regular exercise, and thereby may increase the capacity of the sympathetic nervous system (SNS) to respond to acute stressors without rapidly exhausting its reserves.[5]

Scientific studies on "Om" chanting suggest that the mental repetition of "Om" results in physiological alertness, increased sensitivity as well as synchronicity of certain biorhythms, and an increased sensitivity to sensory transmission.[13] To study the long-term effects of SKY on brain function, EEG changes were recorded among 19 SKY practitioners and compared with the EEG patterns of 16 participants who did not practise SKY, yoga, or meditation. Significant increases in beta activity were observed in the left frontal, occipital, and midline regions of the brain in the SKY practitioners, as compared to controls. These results indicated increased mental focus and heightened awareness in SKY practitioners. It is striking to note that SKY practitioners displayed significantly greater mental alertness (beta activity) than the control group of physicians and medical researchers, whose profession requires development and daily use of these very skills.[14]

To summarize, improved autonomic function, neuroendocrine release, emotional processing, and social bonding following SKY practices may be attributed to VNS and activation of the limbic system, hippocampus, hypothalamus, amygdala, and stria terminalis.

INFLUENCE OF SKY ON ENDOCRINE SYSTEM

According to the neurophysiological model of VNS by yogic breathing, it is assumed that SKY mainly exerts its endocrine effect by modulating the hypothalamic–pituitary–adrenal (HPA) axis, which is essential for fight and flight response and survival of humans. It is likely that SKY releases prolactin, vasopressin, and oxytocin via vagal afferents to the hypothalamus and anterior pituitary. Oxytocin enhances the feelings of bonding and affection. It is associated with parasympathetic nervous system (PNS) functions and is involved in regulating the HPA axis. Oxytocin secretion was found to be low in major depression and it is hypothesized to increase after treatment with SKY. Prolacatin was found to increase.[7]

In a study by Janakiramaiah *et al.*, dysthymic patients were treated as out-patients with Sudarshan Kriya as their sole treatment. Blood analysis revealed elevation of plasma prolactin and stable cortisol after the very first SKY session. This is important since elevated plasma prolactin may be crucial in producing an effective antidepressant response. Stable cortisol levels indicate the experience of SKY is not stressful.[15] Another study revealed reduction in stress hormone levels [cortisol and adrenocorticotropic hormone (ACTH)] along with Beck Depression Inventory reductions. This may support a biological mechanism of SKY in producing beneficial effects.[16,17]

One episode of SKY group practice increased serum brain-derived neurotrophic factor (BDNF) levels but decreased serum cortisol levels. Increase of serum BDNF levels sustained for at least 4 h and was not due to cicardian rhythm. It was concluded that the intervention of SKY practices has profound antidepressant effects, which are highly correlated with its function in normalization of serum BDNF levels.[18]

THERAPEUTIC POTENTIAL OF SKY

Studies on the therapeutic implications of SKY in various psychological and clinical conditions are summarized below.

Stress, anxiety disorders, depression

During various anti-stress programs in several populations, SKY has demonstrated significantly reduced anxiety scores, indicating stabilization of mental activity, enhanced brain function, and resiliency to stress.[19-21] Insomnia is one of the common symptoms of stress that responds to daily SKY practice in the form of improved sleep quality.[19] Tsunami refugees showed dramatic improvement in post-traumatic stress disorder (PTSD) and depression scores after SKY training.[22] In a comparative study to assess the effects of different modalities like Iyengar and Desikachar yoga, Qi Gong, SKY, and a multicomponent yoga intervention (MCYI) in treating Australian Vietnam war veterans with longstanding PTSD, it was found that the interventions that used many tools of yoga, viz. SKY and MCYI, showed the greatest efficacy.[23]

SKY provided a "corrective emotional experience" for healing the cognitive distortions and deep emotional wounds resulting from trauma. SKY treats the cognitive and psychodynamic problems of feeling alone, abandoned, and cast out by society by enabling participants to rebuild a sense of a caring, tolerant, interdependent community in which they are accepted and valued.[24]

Yogic breathing can be taught to large groups in just a few days. SKY literature reported that SKY has been used to relieve stress, anxiety, insomnia, depression, and PTSD after mass disasters such as war (Kosovo, Bosnia, Iraq, and Sudan), earthquakes (Gujurat, India earthquake 2000), floods (Iran 2004),[25] terrorism (New York World Trade Center 9/11),[5] the Southeast Asia tsunami (2004),[26] and Hurricane Katrina.[25] The use of yogic techniques should be considered as an adjunctive treatment in emergency response planning. The Sudarshan Kriya may provide antidote to stress by physiologically counteracting the sympathetic effects. In a normal situation (in the absence of stress), the practice of rapid breathing interspersed with adequate pauses of slow breathing may provide tool for relaxation and vivid imagery.[27] SKY rapidly improves psychological and physiological symptoms of post-traumatic stress, including insomnia, nightmares, anxiety, depression, hyperarousal, overreactivity to triggers, re-experiencing, emotional numbing, social withdrawal, loss of appetite, and angry outbursts. Anxiety, depression, and PTSD are associated with SNS overactivity or erratic activity and PNS underactivity. Evidence suggests yoga breathing normalizes SNS activity and increases PNS tone as indicated by heart rate variability.[25]

Another way in which SKY training can facilitate this change in perspective is by awareness of and management of emotions through regular practice of the Kriya. The SKY literature states, "rather than allowing the emotions to alter the breath (and cause physiological changes which may prove unhealthy), one can skillfully use the breath to transform one's emotional state."[24,28]

In the Lancaster Violence Alternative Program, the adolescent subjects, who were offenders of violent crimes with deadly weapon, murder, rape, armed robbery, and terrorist threats against others were included. They all underwent SKY practice following which The Spielberger State-Trait Anxiety Inventory Test (STAI) showed statistically significant reduction in State anxiety level. Participants also reported that they slept better; did not react to provocation as rapidly; did not experience as much anger; felt less fear at bed time; and generally expressed that they were more calm.[29] Considering the positive impact of SKY on various psychosocial ailments, it is assumemd that SKY can be a helpful adjunct in the treatment of phobias.[5]

Janakiramaiah and colleagues have shown that SKY was effective in treating mild and melancholic depression in dysthymic and unipolar major depressives. Depressed people have a particular EEG brainwave abnormality, which is measured by P300 event related potential (ERP) amplitude. By day 30, there was significant relief from depression in the groups treated with SKY, as measured by the P300 amplitude and standard depression scales. By day 90, their P300 had returned to normal which was indistinguishable

from normal controls and they remained stable and depression free. Several other studies involving dysthymics and melancholics revealed significant improvement of depressive symptoms after SKY practices.[30,31]

It was also reported that SKY exerts remarkable therapeutic effects in treating dysthymia and unipolar diseases and it may be a more acceptable and efficacious alternative to medical management of dysthymia for both acute treatment and relapse prevention. It has the advantage of fostering the patient's autonomy and self-reliance besides cutting health care costs.[25]

A comparative study of 45 hospitalized melancholic depressive patients randomized to electroconvulsive therapy (ECT), imipramine, or SKY demonstrated that all three treatments were effective, with ECT being slightly more so than SKY or imipramine.[32] SKY improved rapid eye movement (REM) latency and slow wave sleep and significantly reduced cortisol; it appears that SKY has powerful biological effects. Compliance with the breathing technique in these studies ranged from 56 to 80 %, compared to 50% compliance with prescription antidepressants (with complaints of significant side effects from medications).[6]

Alcohol and tobacco addiction

Stress is associated with a wide range of physiologic changes. It is also linked to the habit of tobacco and alcohol consumption, which in turn leads to disease states.[33] The progression of alcohol/tobacco-related diseases seems to be directly related to the generation of reactive oxygen species, reactive nitrogen species, and reduced levels of antioxidants.[34,35]

In a study of cancer patients who had completed their standard therapy, researchers have shown that SKY helped to control the tobacco habit in 21% of individuals who were followed up to 6 months of practice.[36]

SKY was tested for antidepressant effect in 60 inpatients of alcohol dependence. Subjects completed the Beck Depression Inventory (BDI) before and after the 2 weeks of this intervention. Morning plasma cortisol, ACTH, and prolactin too were measured before and at the end of 2 weeks. Results demonstrated the antidepressant effects of SKY in alcohol-dependent subjects. Reductions in stress hormone levels (cortisol and ACTH) along with BDI reductions possibly support a biological mechanism of SKY in producing beneficial effects.[16]

THE OXIDATIVE STRESS AND ANTIOXIDANT STATUS

The complex molecular response to stress is mediated by stress genes and a variety of regulatory pathways. Oxidative stress is internal damage caused by reactive oxygen species. Increasing evidence suggests that chronic psychosocial stress may increase the oxidative stress, which in turn may contribute to aging, and etiology of coronary diseases, cancer, arthritis, etc.[37,38]

Sharma *et al.* (2003) found significantly lower levels of blood lactate and higher levels of superoxide dismutase (SOD), glutathione, and catalase in practitioners as compared to nonpractitioners of SKY, thereby suggesting that lower levels of blood lactate and better antioxidant status in practitioners are associated with regular practice of SKY technique.[39]

The effect of SKY on antioxidant enzyme activities in menopausal women was studied. Four groups of women were compared: 40 received hormone replacement therapy (HRT), 40 received 500 mg of Vitamin E daily, 60 practised SKY daily, and 50 served as controls. Within just 30 days, the SKY group of menopausal women exhibited improved antioxidant levels and was proven superior to the beneficial effects seen with HRT or Vitamin E on the antioxidant levels.[40]

An earlier study has reported that SKY practice significantly increases the blood levels of SOD as an indicator of antioxidant status and reduces plasma malondialdehyde (MDA), another such indicator of oxidative stress.[19]

GENE EXPRESSION PROFILING IN PRACTITIONERS OF SKY

A study conducted in All India Institute of Medical Sciences (AIIMS), New Delhi, showed better antioxidant status both at the enzyme activity level and at RNA level in SKY practitioners. This was accompanied by better stress regulation and better immune status due to prolonged life span of lymphocytes by up-regulation of antiapoptotic genes and prosurvival genes in these subjects. Thus, it was concluded that that SKY practice may exert effects on immunity, aging, cell death, and stress regulation through transcriptional regulation.[37]

STRESS-RELATED MEDICAL CONDITIONS AND IMMUNITY

Gerbarg and Brown have found SKY to be helpful in patients with a wide range of medical disorders including chronic fatigue, chronic pain, fibromyalgia, neck and back pain, temoro mandibular joint pain, cancer, diabetes, multiple sclerosis, and asthma. Reducing stress and anxiety is known to ameliorate pain and other stress-related symptoms.[5]

In a study conducted to assess the effects of SKY on lipid profile, pulmonary function, and hemoglobin concentration, significant improvement was found in all pulmonary function parameters in all subjects over a period of 8 days. Thus, SKY may have therapeutic implication in the adjunctive (non-pharmacological) management of cardiovascular and respiratory diseases.[41]

In a subsequent study, significant reductions in blood glucose level, serum total cholesterol, triglycerides, plasma MDA, and lipoperoxidation were observed in type 2 diabetic patients after 4 months of regular SKY practice. The authors suggested a promising potential for SKY as a complementary treatment for patients with diabetes.[42] In a recent study, it was found that SKY practice for 3 and 6 weeks helped an engineering student to overcome examination stress (ES) by improving the lipid profile and hematological parameters.[43]

In a study assessing the neurophysiological responses before, during, and after SKY, an EEG (recorded at 19 cortical sites), electrocardiography (EKG), heart rate variability, galvanic skin response, hand skin temperature, pulse plethysmography, and blood pressure tests were measured. The authors found that SKY practice produced significant changes in all physiological measures. It appears that over a period, the practitioner's health becomes more robust, flexible, and able to deal with the challenges of stress. This suggests that regular practice of SKY may be an important wellness practice.[44]

Spirometry tests in regular SKY practitioners have shown improvement in the lung function of normal healthy adults, which may have significance in serving as an adjunctive complementary treatment modality for improvement in lung function among the patients of obstructive airway disease, asthmatics in particular.[45]

In the mild hypertensives, SKY practices have shown significant decrease in diastolic blood pressure, serum urea, and plasma MDA adducts as an oxidative stress marker. The pattern of change in most of the study parameters was such that values above normal range were lowered, but values within normal range were unaltered.[46]

Some authors have reported that stress reduction techniques (SKY practice) might prove useful to improve the ability to see distant objects and reduce physiological stress activation during every day activities.[47]

Kochupillai *et al.* studied cancer patients who had completed their standard therapy. SKY increased natural killer (NK) cells significantly at 12 and 24 weeks of the practice compared to baseline. There was no effect on T-cell subsets after SKY either in the study group or among controls.[36]

A study was done in AIIMS to enumerate T-lymphocyte subsets (T-helper and suppressor T cells) and NK cells in the peripheral blood of Art of Living (AOL) teachers, normal controls, and cancer patients by flowcytometry in order to find out if there was any change in these groups. The authors observed total T cells and its T-helper subset were significantly higher in AOL teachers and normal controls as compared to cancer patients. A significant difference was seen in NK cells, which were significantly higher in AOL teachers as compared to normal and cancer patients. No significant difference was seen in NK cell population between normal subjects and cancer patients. Since the other factors were the same in normal subjects and AOL teachers, the higher NK cells in AOL teachers could be attributed to the practice of AOL (Sudarshan Kriya).[48] This finding supports the literature on yoga which has found that it can prevent immune suppression following early stage breast cancer surgery.[49,50]

In a study of women diagnosed with breast cancer, significant improvement in quality of life, spiritual well-being, positive states of mind, and perceived stress was observed upon completing SKY training and was maintained at 5-week follow-up.[51] The subjects were evaluated 2 weeks before the SKY practice, 8 days after the SKY practice, and after 5 weeks of regular practice.

SKY induces relaxation, and increases antioxidant defense and NK cells in the body. These observations have important implications for cancer, as they would suggest that (i) SKY may have a preventive role against cancer; (ii) SKY may be effective as a secondary preventive measure, after curative treatment of cancer; and (iii) in metastatic cancer, SKY may delay the progression of cancer, improve the survival and/or quality of life.[52]

A study was carried out to measure the changes in psychological well-being of the individual living with HIV/AIDS following SKY practice. The authors reported significant improvements immediately after the Sudarshan Kriya and Practices (SK and P) intervention, which was not sustained at final follow-up, perhaps due to insufficient sample size to power the study. Qualitative interviews indicated improvements in day-to-day living.[53]

SKY PRACTICE AND SPIRITUALITY

Overall, human transformation or spirituality is an aspect which science is just beginning to measure. In a study carried out using A Spiritual Quotient Questionnaire to quantify the change in the people who attended Art of Living course, it was found that a 4-day SKY training workshop completely transforms the outlook of people toward life.[54]

CONCLUSION

The ancient yogic science of breath is the science that deals with body, breath, mind, soul, and ultimately, the universe itself. Just as a thread links the kite-flier to his kite, breath is said to link the mind with the universal force. Medical science is currently rediscovering and validating many of the ancient health practices from traditional cultures worldwide. SKY is one novel practice that is undergoing extensive research to show it as an evidence-based treatment. SKY has been reported to be effective not only for treating stress and anxiety, but also for PTSD, depression, stress-related medical illness, and substance abuse, and for rehabilitation of criminal offenders.

SKY practices are cost-effective, well-tolerated tools that can be easily integrated into diverse community care models. SKY relieves stress and develops an individual's mind–body–spirit so that they can be happier, healthier, and possibly even longer lived. In the competitive modern world, in which stress and anxiety are part of everyday life, adding a time-honored, evidence-based breathing program like SKY may facilitate a healthy life.

Further studies are needed to assess the therpeutic potential of SKY in the treatment of bipolar disorder, dissociative disorders, or schizophrenic spectrum illnesses and various stress-induced illnesses.

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