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# OVERVIEW OF RESEARCH ON SKY: SUDARSHAN KRIYA YOGA

Kritika Jain[1], Himanshu Kharadi[2]
[1,2]MBBS, Doctor S.N. Medical College

***ABSTRACT: Since the 1970s, meditation and other stress-reduction techniques have been studied as possible treatments for depression and anxiety. One such practice, yoga, has received less attention in the medical literature, though it has become increasingly popular in recent decades. Among all the yoga practices Sudarshan Kriya Yoga(SKY) has been found to be very effective. SKY has four breathing components Three stage – slow Ujjayi, Bhastrika, Om chanting, Sudarshan Kriya (cyclic rhythmic breathing). SKY is a unique breathing process, which removes stress from the body. Negative toxins are flushed out and each cell is flooded with new life to energize body and mind. This experience of centeredness, freedom and fulfillment releases neuropeptides, which influence the immune system positively and hence, the whole physiology. It demonstrated a 68-73% success rate in treating people suffering from depression, regardless of severity of the depression, also produced highly beneficial biological effects on brain and hormone function. The P300 ERP EEG brainwave pattern and NREM brainwave pattern, which measure electrical brainwave activity and are abnormal in many depressed people, returned to the normal range by ninety days. Plasma prolactin, a hormone in the blood which is believed to be a key factor in producing relief from depression, increased after the very first SK&P session. Levels of plasma cortisol (the stress hormone) decreased significantly. It is proclaimed to have various psychological effects, for example- when introduced in prisons (Prison Smart Program) showed significant reduction in violent behavior, overall reduction in anxiety, anger insomnia, depression, stress, fighting tendency and also improved overall quality of life. Indicating the physiological effects of SKY includes reduction in lactate levels, release of anti-oxidants, overall increase in brain activity, increased immunity(specifically NK cells-mainly in cancer patients) The effects on molecular level showed that SKY can induce changes in gene expression also.***

***Key words: SKY stages – benefits – effects on psychology, physiology, molecular level – EEG changes – future aspects***

## I. INTRODUCTION

Sudarshan Kriya practitioners report profound subjective experiences, some claim to be almost magical. Furthermore, the science behind these experiences is equally intresting.SKY has 4 breath components-1) Three stage- slow ujjayi 2) Bhastrika 3) Om chanting 4) Sudarshan kriya(cyclical rhythmic breathing). Ujjayi breathing is a slow breathing (2-4 cycles per min, cpm ) against airway resistance. Lower lobes of lungs expand during 1st stage (hands held at waist); middle lobes expand during 2nd stage(hands held at chest level) and upper lobes expand during third stage (palms placed on upper back, elbows pointing upwards).

Specific characters of THREE STAGE PRANAYAMA namely slow breathing, airways resistance, breath holding, expansion of lungs and chest wall-all contribute to increasing parasympathetic tone, balancing and conditioning the autonomic nervous system. This explains the feeling of calmness, at the same time feeling of aletness and attentiveness during three stage pranayama. The proposed mechanism is a shift to parasympathetic dominance by a vagal stimulation from vagal somato sensory afferents in the glottis, pharynx, lungs and abdominal viscera. During the breath holding at the end of inspiration in ujjayi breathing, 52% increase in oxygen consumption and metabolic rate has been described.

IN BHASTRIKA- second component of SKY, also called as bellow's breathing, breath is forcefully inhaled and than exhaled using strong abdominal muscle contractions along with the hand movements. Breathing rate is approximately 30 breathes per minute. Bhastrika pranayama causes autonomic sympathetic activation and CNS excitation with activation of temporo-parietal cortical areas, producing rhythms that are similar to gamma frequency bands, hypothesized to reflect synchronization of neural assemblies. The subjective experience is of excitation during bhastrika followed by emotional calming with mental activation and alertness.

OM CHANTING-Third component has complex effects on the brain. The verbal stimulation and the vibrational component of the chant probably contribute to the activation of wernicke's area and the thalamus. Om chanting is shown to decrease metabolism, decrease heart rate and increase peripheral vascular resistance. These findings signify increased mental alertness, increase vagal tone and decreased sympathetic activation, consistent with physiologic relaxation.

SUDARSHAN KRIYA- fourth component utilizes three different rates of breathing; slow (8-14 cpm); medium (30cpm) and fast(150-180 cpm). Practisioners often describe feeling peaceful, clear minded, happy, focused and connected to others. It is proposed that medium and fast cycles of SKY activate thalamic projections that excite sensory-motor cortex and quiet frontal and parietal occipital cortex. It is proposed that during SKY a sequence of breathing technique of different frequencies, intensities, lens and with and inspiratory and expiratory holds, creates variegated stimuli from multiple visceral afferents, sensory receptors and baroreceptors. These probably influence diverse fibre groups within the vagus nerve, which in turn

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induce physiologic changes in organs, glands and ascending fibres of thalamus, the limbic system and cortical areas. This may account for the rapidity and diversity of SKY effects. It is a common observation that many people respond to SKY within days, with immediate improvements in mood and anxiety. It is hypothesized that the different cyclical rhythms of SKY create variety of vagal, thalamic and cortical effects.

## II. PSYCHOLOGICAL EFFECTS OF SKY

Fahri and his associates studied 103 Swedish individuals-55 SKY Group and 48 in the Control group. Control group simply relaxed, while SKY group practiced the breathing processes. At the end of six weeks, participants in SKY group lowered their degree of anxiety, depression and stress and increased their degree of optimism (ANOVA; $p<0.001$). Anti depressant efficacy of SKY has been demonstrated at NIMHANS, Bangalore through a number of studies. It was comparable to the drug imipramine and yet it was without side effects and also cost effective. Subjects with insomnia respond to SKY in a positive way. It has also been found useful in anxiety disorders, medical students with examination anxiety and care givers of dementia patients. Subjects with post traumatic stress disorder (PTSD) experience improvement in physical and psychological symptoms. The overall effect is amelioration of feelings of fear, neglect, abuse, rejection, depression, isolation and worthlessness. In those addicted to alcohol, SKY reduced the level of depression and anxiety significantly; prolactin levels increased and cortisol level declined. Similarly, individuals with opiate dependants experienced increased enthusiasm and happiness and felt better control over their emotions and had decreased need for agonists and hypnotic medications (unpublished data). Introduction of SKY in prisons (Prison Smart Program) showed significant reduction in violent behavior, overall reduction in anxiety, anger insomnia, depression, stress, fighting tendency and also improved overall quality of life.

## III. PHYSIOLOGICAL EFFECTS OF SKY

Blood lactate levels(indicative of physical and mental stress) declined significantly among police trainees(highly stressed group ) practicing SKY .conversly there was increase in antioxidants enzymes .the level of superoxide dismutase( SOD), catalase and glutathione; major defence against oxidative stress , were all found to be significantly higher in SKY practioners compared to the control group. These data , suggest thst people who practice SKY have an improved antioxidant status and defence against oxidative stress.SKY appears to affect brain function also with EEG changes indicative of a state of relaxed alertness. Significant increase NK cells among those practicing SKY compared to normal controls and cancer patients in remission has been observed. Cancer patients in remission demonstrated significant increase in NK cells , when made to practice SKY. Breast cancer patients also demonstrated increase in NK cells. Their quality of life was better and side effects of chemotherapy were less(unpublished data). In another study advanced braest cancer patients showed better quality of life. Those addicted to tobacco gave up this habit. Atleast 21% success rate has been documented.

EFFECTS ON MOLECULAR LEVEL showed that SKY can induce changes in gene expression also.

## IV. EFFECT OF MEDITATION ON STRESS INDUCED DISORDERS

Recent data indicates that mindfulness is useful in improved subjective well-being, reduced symptoms of psychological distress, decreased emotional reactivity; decrease in ruminations and dysfunctional cognitions; enhanced ability to deal with negative mood states and emotional well-being, improved sleep and an overall perceived better quality of life. In addition, research has also looked into the effectiveness of meditation on various psychological disorders that are linked to stress such as mood disorders, anxiety disorders, relapse in substance use disorders. Various studies including randomized control trials have demonstrated that, in patients with major depression or bi polar disorder, mindfulness based cognitive therapy (MBCT) along with treatment as usual( TAU) is significantly superior to TAU in not only reducing relapses but also in reducing residual depressive symptoms , inter-episodic anxiety and ruminative thinking.

## V. EFFECTS ON EEG

*Study Design and Methodology:*

Five regular practitioners of SK formed the study group. They were connected with Ved Vignan Maha Vidya Peeth, who regularly practiced and taught SK. They had attended the basic course (22hrs), advanced course (4 days) and the teachers training course. All were females, with a age range from 35- 45 years, with similar socioeconomic background and education. None had a psychiatric illness, neurologic illness, and none of the subjects were on chronic medications. All the subjects were asked not to take any central nervous system stimulants/ caffeine prior to the test.

EEG: All recording were done in similar conditions. The subjects were asked to be comfortable, seated on a chair, with their eyes closed. Electrodes were placed according to the 10- 20 system of electrode placement; the recording was conducted on a 21 channel digital EEG machine, (Profile, Oxford UK), with AD conversion of 22 bits, and sampling frequency of 256Hz. Filter settings were 0.5- 50Hz, a standard sensitivity of 7 uV/mm and a paper speed of 30 mm/sec.was used for recording the data. Artifacts free epochs of 6sec. duration were selected at the rest condition, during the Pranayam, Bhastrika and the 3 phases of SK in the first cycle and the 6th cycle, at the end of the SK, and every 5mts after that for 20 minutes. The pruned data was subjected to FFT analysis using MATLAB. The EEG frequency bands were defined as follows: Delta – 0-4 Hz, Theta – 5-7 Hz, alpha –8-12Hz, Beta 1:13-18 Hz, Beta 2: 19-30 Hz., and the power calculated in each band and corresponding frequency maps were drawn.

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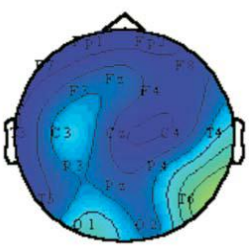
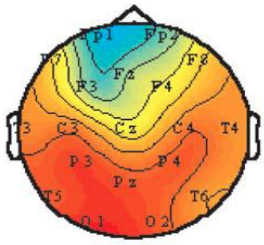
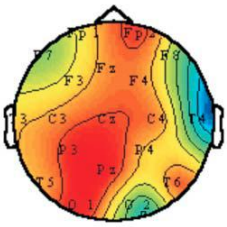
*Results*
Coherence: An increase in coherence was observed in the 6th cycle predominantly in the fronto-central regions in the beta band, and posteriorly in the alpha band. Frequency Analysis: There was an increased alpha activity posteriorly during the SK. In addition a central midline theta activity was observed. The resting EEG demonstrated an increased focal beta activity. GSR- Increase was observed during the SK.

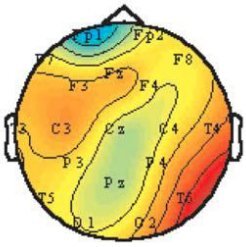
*Discussion:*
The increased coherence suggests increased connectivity. This is suggestive of more efficient information processing. The central midline theta activity, and increase in GSR suggests activation and the increased alpha is suggestive of relaxation. Thus there is a combination of relaxation and activation during the SK. Larger no. of subjects need to be studied to define these changes further.

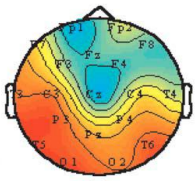
EEG Recording of different areas of brain-


Pre Kriya


Med Phase


Post- parnayam


Fast-phase 7th cycle


Slow phase 7th cycle

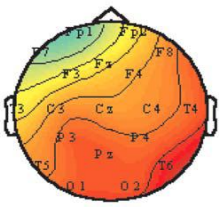

1Minute after kriya

Table 1

## VI. EFFECT OF SKY ON HIV POSITIVE PATIENTS

With the availability and access to anti-retroviral therapy (ART) the life span of HIV infected individuals has increased leading to the issues of quality of life (QOL) in people living with HIV (PLHIV)1,2. Cross-sectional studies with QOL scores in HIV patients have been done. Tools and techniques: Karnofsky scale, a performance scale that rates a person's normal activities, was used by the clinician to evaluate the patient. This was a one-time evaluation at baseline for assessment of physical and mental health for enrolment. Only those with scores above 70 were included in the study.

*Quality of life scales:* The standardized WHOQOL-HIVBREF tool for assessing QOL scores for HIV having 31 items covered in the following six domains was used in this study.

- Physical domain: pain, physical botheration, daily energy and sleep.
- Level of independence domain: treatment need, getting around ability, daily activity satisfaction and working capacity.
- Psychological domain: enjoyment, concentration, appearance acceptance, self-satisfaction and negative feelings.
- Social domain: other's acceptance, personal relationship satisfaction, sex life and social support.
- Environmental domain: feeling of security, physical environment, adequacy of finance, access to information and health services, leisure activity opportunity, living-place satisfaction and transport.
- Spiritual domain: meaningful existence, guilt related to HIV status, botheration/anxiety, fears of future and worry of death.

*Biological parameters*: Blood pressure, height and weight were recorded at the three points at 4-weekly visits at the clinic by trained research nurses of the team; medical records were maintained by the clinicians. At baseline and at the end, 6 ml blood was drawn for CD4 counts estimation.
*Interview*: The WHOQOL-HIVBREF questionnaire was interviewer-administered to maintain uniformity. This was done at baseline and at 4, 8 and 12 wk visits. The I-SKY participants were interviewed soon after training within 2-3 days. The socially desirable responses, as a possibility, was minimized to some extent as the WHOQOL-HIVBREF has questions on varied domains in a mixed order rather than being arranged domain-wise. Also the team attempted to change the interviewers at each visit of the participant.
*Outcome*: This study was aimed at comparing the changes in the quality of life scores in healthy PLHIV between the intervention arm (I-SKY) and control arm (O-SOC). The QOL scale WHOQOL-HIVBREF was administered to all participants of both arms at the start of the study, 2-3 days after the initial 6-day SKY training and after 4, 8 and 12 wk of training for I-SKY participants and to O-SOC participants after 4, 8 and 12 wk of baseline study. The QOL data were analyzed according to scores in the six domains.

## VII. EFFECT ON ENDOCRINE SYSTEM

Stressors cause sympathetic overdrive ensuing in the "fight or flight" response, causing the release of hormones (example- epinephrine, norepnephrine) that prepare the body to protect itself from a threat. This heightened autonomic arousal results in a feeling of anxiety, fear or alarm and cause a state of heightened alertness. Meditation consciously results in triggering of the parasympathetic systems resulting in a relaxation response. This results in a wakeful

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hypometabolic state with a reduction in heart rate, respiratory rate, systolic blood pressure and oxygen metabolism. Regular practice of meditation results in regular elicitation of the relaxation response and increases the ability to manage stress. Urinary vanillymandelic acid (VMA), a marker of the stress hormones epinephrine and norepinephrine are lower in persons practicing SKY. Still other studies documented a decrease in galvanic skin resistance, which was found to be higher during the stress response. Dopamine is a neuro transmitter that is crucial for motivation and fronto-limbic affect systems of the brain. The finding of increased dopamine release in limbic brain regions during meditation is also in line with the activation findings of limbic areas during meditation. The increase in dopamine is thought to reflect enhanced internalized attention. Several other studies of meditation have observed increase in blood plasma levels of melatonin and serotonin. Both these neuro chemicals are closely linked, paly an important role in mood stablisation, positive effect and stress prevetion and are implicated as the chemical cause of affe3ctive disorders such as depression. Long term meditation might have additional neuroplastic effects. Meditation- induced cortical plasticity due to years of dedicated practice may result in increased thickness of the right prefrontal cortex and insula and may increase the gray matter concentration in the medial orbito-frontal region. Interestingly, the right pre frontal cortex is known to be crucial for sustained attention and concentration functions. The insula is an area that is important for interoceptive attention and breath awareness. The medial orbito-frontal region is important for emotion control and its increase may help understand the emotional resilience of long term mediators. Indeed, a study investigating emotional reactivity of long term mediators showed reduced psychological , physiological and electro-physiological reactivity to stressful stimuli, thereby providing the neuro physiological evidence to support the state of meditation induced dispassion.

## VIII. RESULTS

A total of 109 participants were screened, of whom 70 were found to be eligible. Of these 70, nine declined to participate in the study mainly for logistic reasons (long distance was a major inhibiting factor and likelihood of HIV status disclosure during SKY weekly follow up visits in the intervention arm). Overall, 61 PLHIV were enrolled and randomly assigned to two arms (Fig. 1). Among the 61 study participants in both arms (31 in SKY intervention arm, I-SKY and 30 in control arm, O-SOC), most participants were ever-married; with over 40 per cent widowed or living separately; literate with mid-level schooling and with a job. The QOL scores for various domains and baseline data were not significantly different for the participants of both the I-SKY and O-SOC arms at baseline.

## IX. LIMITATION

Over the years , multitude of studies including RCTs , meta anylysis and systematic reviews have proven the efficacy of meditation-based therapies across variety of physical and psychological conditions. Howvevr, research has not been able to tease out the specific effects of the therapy from the non specific ones. In terms of subject-relate dissues, one of the comnest methodological limitations in selection bias as most subjects choose to undergo meditation and therefore effects cannot be generalized to unmotivated subjects and secondly, absence of objective ways to verify the level of proficiency and time spent on meditation weaken all studies.
Some of the chalanges that future research needs to address are-

1. Developing a consensus on a working definition of meditation that is consisitent across heterogenous group of practices.
2. Studies could look into comparing different tyoes of meditation practices .
3. Special attention needs to be paid to designing case – control studies and selecting controls
4. Research needs to take into consideration the “dose-response”relationship, that is , level of proficiency, appropriate study duration, effective meditation time.
5. Process research is required to understand the specific effects of meditation.

## X. CONCLUSION

In summary it can be stated that till now more than 80 research papers have been published on sudarshan kriya and related techniques. From these publications it can be concluded that SKY is a beneficial, low risk and low cost adjunct to alleviate anxiety, depression, everyday stress, PTSD, stress related medical illness, substance abuse and rehabilitation of criminal offenders. Mechanisms contributing to a state of calm alertnessincude increased parasympathetic drive, calming of stress response system, neuroendocrine release of hormones and thalamic generator. At the molecular level, it has been demonstrated that SKY has a rapid and significantly greater effect on gene expression in peripheral blood mono nuclear cells (PBMC) compared to controls. This possibly forms the basis for longer term cell biological and higher level health effects. Studies suggest that SKY practicing subjects are resistant to oxidative stress and show higher level of protection from cancer and cardio vascular diseases.

*Future Aspect*

Further studies are required both at basic level and clinical level. There is no need to understand in greater detail as to how SKY affects changes as physical, mental, emotional and spiritual level . also randomized studies are needed to see the effects of SKY in various clinical setting specifically in disease states such as asthma, migrane, gastric and duodenal ulcer, irritational bowel syndrome, menstrual tension, menopausal syndrome and many more.

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