

THE SCIENCE of BREATH



How the use of breath can eliminate stress, transform negative emotions, support the whole physiology, and restore health and wellness

Vibrant health is the basis for success and happiness in our lives. Although we know what a healthy lifestyle is, we often overlook a key factor – chronic stress – which negatively affects all aspects of our health and well-being, linked even to life-threatening diseases. The extensive mind-body research literature shows how stress may affect all levels of our physiology. Fortunately,

there are methods that can systematically relieve stress and reverse its influences. One of the most well-studied and effective stress-relief and wellness programs is based on yogic breathing exercises. Current research shows powerful health restoration and promotion effects of these practices, both to increase wellness and as possible adjunct tools in therapy.

Background

All of us would like to be and remain healthy, and enjoy a high degree of wellness for success and happiness. Health and wellness are more than the mere absence of illness: to be well is to thrive physically, emotionally, and psychologically. To enjoy true wellness, we know what we should eat and drink, and that we should exercise regularly and get enough sleep. However, we often overlook one of the most important determinants of wellness - the stress in our lives. Chronic stress can break down the smooth interactions in our mind-body axis and negatively affect every aspect of our lives.

A rapidly growing body of research now robustly links psychological and behavioural factors to physiological parameters and to the incidence and biology of a broad spectrum of diseases. These include not only simple diseases, such as the common cold, but also chronic and life-threatening ailments ranging from cancer to coronary heart disease, asthma and HIV-1 infection. In addition, the very diagnosis and treatment of life threatening conditions often induces acute and chronic stress that can further exacerbate disease progression.

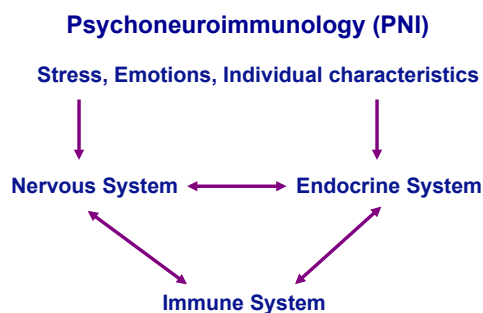


Figure 1. Large body of psychoneuroimmunology (PNI) research has shown that our thoughts and emotions can powerfully affect the brain, endocrine, and immune system function.

How can psychological and behavioural factors affect our physiology and overall well-being so dramatically? A large body of psychoneuroimmunology (PNI) research shows that our thoughts and emotions can powerfully affect the brain, endocrine, and immune system function. For example, when we are stressed, specific hormones are secreted which may have beneficial effects in the short term, but if sustained inhibit the immune system. For example, it has been shown that during the final exam period, the activity of disease fighting cytotoxic T-cells (a specialized immune cell) in medical students is decreased 25-fold. Under this condition, when the immune system is not function-

ing optimally, it is much easier for pathogenic bacteria and viruses, as well as cancer cells, to thrive in our body. As a result we get sick.

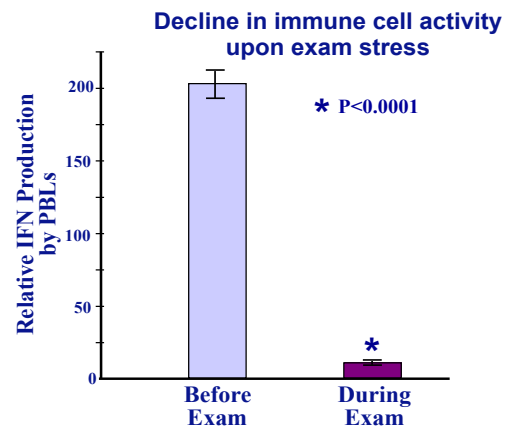


Figure 2. The activity of disease fighting immune cells in medical students is decreased 25-fold under exam stress.

Conversely, “positive” emotions, such as joy, love, and enthusiasm, produce chemical messengers that can affect the brain, endocrine, and immune systems in positive ways. This results in improved resistance to disease and better overall health. Current PNI research has also shown that psychological and immunological functioning can be enhanced through certain cognitive behavioural stress management programs. One of the most well studied and effective such program is derived from yoga – The yogic science of breath.

Processes to Counter Stress and Increase Wellness

The yogic science of breath is a precise, 5000+ year-old science of health promotion. It is one of the first sciences to recognize the impact of the mind and emotions on creating and restoring optimal health. One of the most comprehensive breathing techniques derived from this science is Sudarshan Kriya (SK). SK is understood to use specific rhythms of breath to eliminate stress, support the various organs and systems within the body, transform overpowering emotions, and restore peace of mind, and thus support the whole mind-body system.

SK and its accompanying practices (SK&P) have been taught by the Art of Living Foundation to millions of people worldwide, and continue to be independently investigated by modern medical science at universities, hospitals and other research institutions. The following is a summary of some key published findings so far and ongoing research on SK&P.

Research Summary

Improved wellness parameters

To assess possible effects on wellness parameters in healthy individuals, Swedish adults were instructed in the SK&P program, which they practiced daily for six weeks. The control group was instructed to relax in an armchair each day for a certain time during the same period. Various instruments were administered before and after the intervention. The data suggest that participants in the SK&P group, but not the control group, significantly ($p < 0.001$) lowered their degree of anxiety and depression (Hospital Anxiety Depression Scale), stress (Stress and Energy Test), and also increased their degree of optimism (Life Orientation Test). The data obtained suggest that healthy people may improve various aspects of their wellness simply by learning and applying a program based on yoga and yogic breathing exercises.

SK&P increases wellness in healthy people

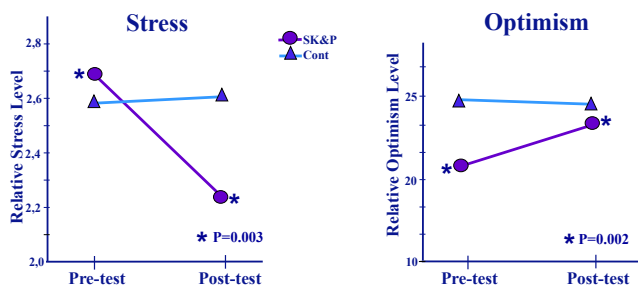


Figure 3. SK&P significantly decreased stress and increased degree of optimism in healthy adults, indicating improvement of wellness.

Effect on Depression

It is noteworthy that the population in the industrialized part of the world, although having a higher life expectancy, has a relatively high incidence of psychological and mental disorders. According to a publication from the EU Commission, more than 27% of adult Europeans experience at least one form of mental health problem each year, most commonly anxiety and depression. By 2020 depression is expected to be the highest-ranking cause of disease in the developed world with a very significant financial burden as well. Thus, there is an urgent need to develop new strategies for fighting depression.

Several independent studies have investigated the efficacy of SK&P in reducing clinical depression. SK&P has been shown to have a 68%–73% success rate in the treatment of clinical depression, regard-

Independent research has shown that Sudarshan Kriya and accompanying practices significantly:

- Reduce levels of stress (reduces cortisol – the “stress” hormone)
- Benefit the immune system
- Relieve anxiety & depression (mild, moderate & severe)
- Enhance brain function (increases mental focus, calmness & recovery from stressful stimuli)
- Enhance health, well-being & peace of mind
- Relieves Post Traumatic Stress Disorder (PTSD) symptoms
- Affects the mind-body system at the molecular level

less of severity. Relief from depression, determined by psychiatric evaluation and standard psychiatric measures (Beck Depression Inventory - BDI, Hamilton Depression Rating Scale-HDRS, and others), was experienced within a few weeks. At the three-month follow-ups, patients remained stable and in remission. Published studies further suggest that SK&P normalises patients’ brainwave patterns, increases serum prolactin (a “well-being” hormone), and is comparable to standard anti-depressant drug regimens. Yet it is safe, free of unwanted side effects, is cost-effective, and self-empowering.

SK&P is effective against clinical depression

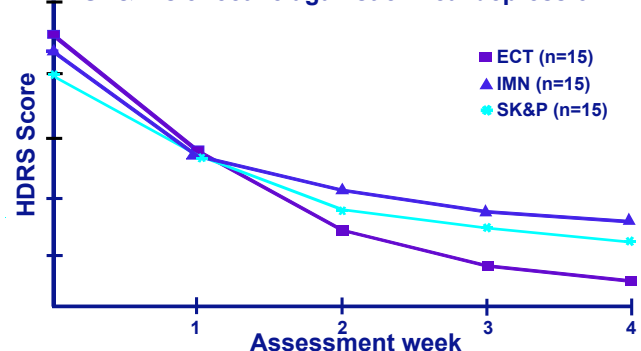


Figure 4. SK&P significantly reduced clinical depression within a few weeks. HDRS, Hamilton Depression Rating Scale; ECT, electroconvulsive therapy; IMN, imipramine (drug).

Effect on Cortisol, the “Stress Hormone”

Several studies have demonstrated a significant decline in cortisol levels following regular practice of SK&P. In one study, blood cortisol, known as the “stress hormone”, was measured. Experienced

SK&P practitioners (Group 1) were compared with beginning practitioners (Group 2) during their first SK&P sessions, and also before learning SK&P, while listening to classical music (Group 3). Among beginners, the fall in cortisol levels was significantly greater during SK&P than when listening to classical music, suggesting that SK&P produces a better relaxation response. In addition, experienced SK&P practitioners had significantly lower blood cortisol levels before the start of the SK&P session than the beginning practitioners. This indicates that they experienced less stress under the demands of daily living. A significant further decline in serum cortisol levels during and following the SK&P session, among both beginning and experienced practitioners, suggests that regular practice of SK&P develops progressively greater levels of both relaxation and resilience to stress.

Effect on Blood Lactate

Blood lactate is another biochemical measure of stress. It has been shown that under extended psychological stress lactate levels in the blood are increased. Participants in police training, a highly stressed group whilst undergoing intense physical and emotional training daily, were chosen for the possible effects of SK&P on lactate levels. Some trainees were assigned to learn and regularly practice SK&P whereas others were kept as controls. After five months, blood was drawn before and after the SK&P practice and lactate levels were determined. Before the practice, indicating basal levels, there was a significant four-fold lower level of blood lactate in SK&P practitioners compared with controls. After a session of SK&P, there was a further significant drop in blood lactate levels, whereas no changes were observed in the control group. These results indicate that SK&P induces a state of relaxation.

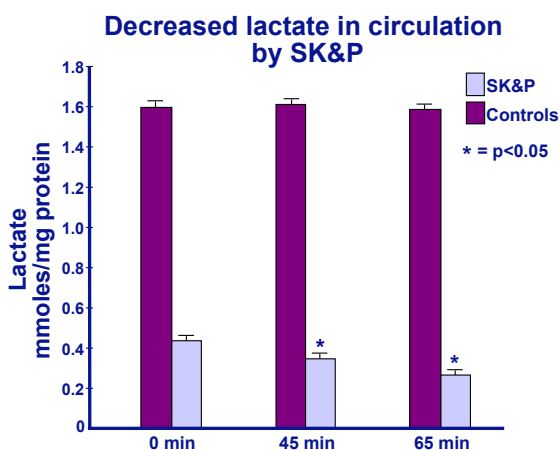


Figure 5. SK&P significantly decreased Lactate (an indicator of tension and stress) in the blood of police trainees. Note the significantly lower level before SK&P that is further decreased upon practice.

Effect on Antioxidant Enzymes

Repeated exposure to environmental pollutants and metabolic by-products result in the formation of free radicals. These react with oxygen and cause oxidant damage, contributing to development of many diseases, including cancer and cardiovascular disease, and accelerate the aging process. To counteract free radicals, the human body has a defense system in the form of antioxidant enzymes. A study was thus conducted to assess the effect of SK&P on antioxidant enzymes in the same group of police trainees as was used in blood lactate studies. The levels of three major antioxidant enzymes—superoxide dismutase (SOD), catalase, and glutathione—were measured in SK&P practitioners compared with controls. All three antioxidant enzymes were found to be significantly higher in SK&P practitioners than in the control group after five months at baseline measurements. In addition, there was a further increase in all enzymes upon practice of SK&P with no significant change in the control group. These data suggest that people who practice SK&P have an improved antioxidant status and thus an enhanced defense against free radical damage.

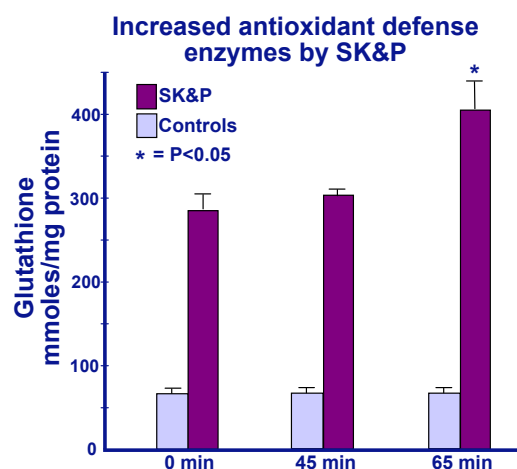


Figure 6. Increased antioxidant enzyme glutathione by SK&P practice. Note the significantly higher level before SK&P that is further increased upon practice.

Effect on Immune Function

The immune system protects us from disease. Natural killer (NK) cells are the surveillance cells of the immune system. They are capable of destroying tumor cells as well as infected cells. Previous work has shown that NK cell activity is inhibited by psychological stress. The possible effect of SK&P on NK cells was studied on three groups: SK&P practitioners, normal individuals not practicing SK&P, and cancer patients in remission. NK cells were significantly higher in the SK&P group than in either non-practicing individuals or in cancer patients in

remission. The cancer patients then learned SK&P. After 12 and 24 weeks of regular practice, there was a significant increase ($p < 0.001$) in the NK cell count of cancer patients who practiced SK&P compared with a control group of cancer patients. This is particularly encouraging, since cancer survivors have abnormally low levels of NK cells, and NK cells are believed to be important in the body's defense against new and recurring cancers.

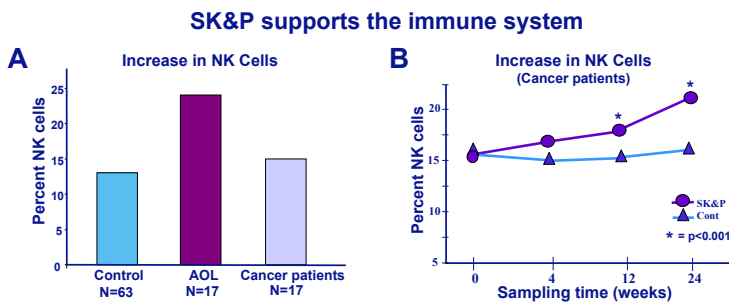


Figure 7. A) NK cell levels in blood were compared in normal controls, normal SK&P practitioners, and cancer patients. B) Cancer patients learned SK&P or were left as controls, and NK cell levels were determined at indicated time points.

Improved Brain Function

To study the long-term effects of SK&P on brain function, EEG (electroencephalogram) changes were recorded in 19 SK&P practitioners outside of the practice of SK&P, and compared with EEG patterns of 16 controls (doctors and researchers who did not practice SK&P, yoga, or meditation). Significant increases in beta activity were observed in the left frontal, occipital, and midline regions of the brain in the SK&P practitioners, as compared to controls ($p < 0.05$). These results are interpreted by neurologists as indicative of increased mental focus/heightened awareness in SK&P practitioners. It is striking to note that SK&P 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.

SK&P increases EEG beta measures indicative of alertness

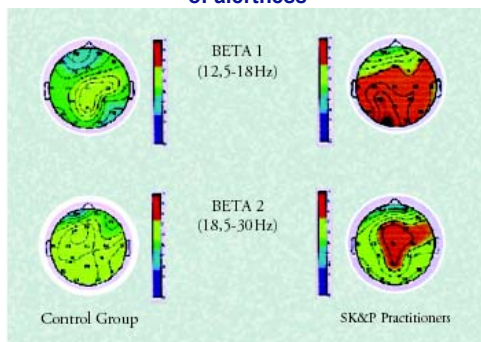


Figure 8. Significant increases in beta activity were observed in the left frontal, occipital, and midline regions of the brain in the SK&P practitioners, as compared to controls ($p < 0.05$).

EEG activity was also studied during the practice of SK&P in five females of similar age, socioeconomic, and educational backgrounds. This study found an increase in EEG alpha activity, with interspersed persistence of beta activity. This indicates a state of relaxation co-existing with heightened alertness.

Relief From Post-Traumatic Stress Disorder (PTSD)

Traumatic events, such as natural or man-made disasters, can induce high rates of psychiatric morbidity, including PTSD, depression and suicidal tendencies. A study evaluated the possible utility of a modified SK&P program alone or followed by a trauma reduction exposure technique (TIR) on PTSD and depression in survivors of the 2004 South-East Asian tsunami. The study population consisted of 183 survivors from 50 coastal fishing villages in the south-east coast of India which were among the most severely devastated in the tsunami. Subjects who scored 50 or above, indicative of PTSD, on the Post-traumatic Checklist-17 (PCL-17) were assigned to one of three groups: modified SK&P, SK&P+TIR or 6-week wait list (controls). Measures for PTSD (PCL-17) and depression (BDI-21) were performed at baseline and at 6, 12 and 24 weeks. At 6 weeks, and stable through 24 weeks, there was a very significant reduction in PTSD and depression symptoms (65% and 85%, respectively; $p < 0.0001$) in the SK&P group with no significant change in the controls. The addition of TIR did not improve results obtained by SK&P alone. These results suggest that SK&P helps relieve psychological distress following mass disasters.

Relief from PTSD and depression by modified SK&P (BWS)

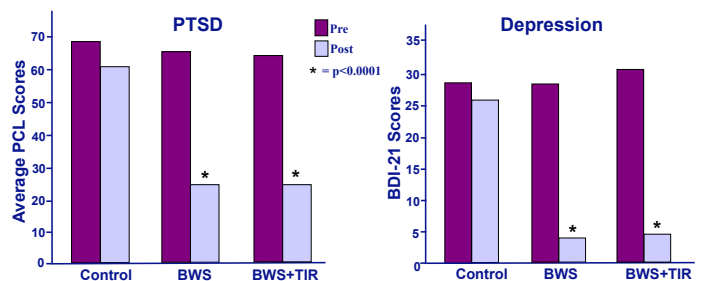


Figure 9. A modified form of SK&P (BWS) either alone or in combination with a trauma reduction program (TIR) was tested on survivors of the 2004 tsunami. These data suggest that SK&P effectively relieves both PTSD and depression symptoms, regardless of TIR.

Improved Emotion Regulation

Difficulties regulating emotional responses to events in our lives play essential roles in mood, anxiety, and personality disorder. A study examined the neurophysiological correlates of *cognitive reappraisal*

(the ability to mentally reframe the meaning of events) in SK&P practitioners and controls. Participants were presented aversive pictures and were asked to cognitively change their emotional appraisal of the meaning of the pictures by coming with an alternative more positive interpretation of each picture. Results indicate that while initially both groups successfully reduced their negative feelings to the aversive pictures, the effect of reappraisal persisted longer in the SK&P group. This indicates that SK&P can help regulate the emotional response and thus help psychological wellness.

Effect on gene expression

The blueprint of our physiology is contained in the DNA that is present in the nucleus of all cells in our body. The knowledge in the DNA is contained in packets of information called genes. Genes can be either turned on or off in response to environmental cues in a process called gene expression. For all physiological processes, as well as in pathological conditions, it is ultimately changes in gene expression that determines the final state (phenotype) of the cell, tissue, and the organism.

One study assessed 42 SK&P practitioners and 42 non-practitioners. Antioxidant enzyme levels in the blood were compared with their gene expression levels in white blood cells. There was a better antioxidant status both at the enzyme level, consistent with earlier results summarized above, and corresponding gene expression patterns, in white blood cells of SK&P practitioners. This suggests that the effects of SK&P on antioxidant enzymes are due, at least in part, to changes in gene expression. Furthermore, there was indication that gene expression that help survival of white blood cells may be activated by SK&P.

In another study, acute global (for all of the genes) changes in gene expression were investigated upon SK&P practice. Blood was drawn just before and after SK&P (on two separate occasions), or a control regimen of nature walk + listening to classical music (also on two separate occasions). Gene expression profile in white blood cells was determined. The results show that SK&P significantly changed the global gene expression profile compared with the control regimen. Most of the differentially expressed genes in the SK&P group were distinct belonging to different gene families. These findings suggest that the beneficial effects of SK&P on different levels of the physiology may be mediated by molecular events.

Ongoing Studies

In addition to the research that is summarized above, there are a number of additional studies that are currently ongoing. Some of them are highlighted below. Department of Neurosciences, Fatebenefratelli Hospital (FH) in Milan, Italy, is conducting a study on patients with depression, generalized anxiety, and panic attacks. It is a controlled and randomized trial with 140 patients in each arm to assess the rates of depression, psychosis, and cognitive functions by standard self-report questionnaires and clinical interviews. In addition, cardiological and respiratory state is tested using Respiratory Sinus Arrhythmia (RSA), a naturally occurring variation in heart rate during the breathing cycle. A pilot experiment from 2009 suggests that depression is decreased by 60%, social psychosis and anxiety by 40%, and improvements in cognitive functions and RSA. The study will be finished in the end of 2011.

Cancer Clinic, Oslo University Hospital Ullevaal, Oslo, and University of Oslo, Norway, is conducting a study on breast cancer patients. It is a controlled and randomized trial with 60 patients in each arm of the study. The measurements are made at the time of recruitment, after the SK&P intervention, and six months after the SK&P intervention. The rates of psychological disturbances, such as depression, anxiety, and stress, are being evaluated as well as the stress hormone cortisol in saliva. Proinflammatory cytokine production and components of the antioxidant enzyme system in blood is being measured. The study is scheduled to be finished in mid-2012.

Center for Investigating Healthy Minds, University of Wisconsin-Madison, USA, is conducting a research project on the effects of SK&P for Veterans returning from war who have PTSD. Pilot results suggest that there are reductions in PTSD, anxiety and sleep problems. The investigators are planning a major study comparing SK&P to Mindfulness Meditation and traditional treatment to commence in 2012.

Semel Institute for Neuroscience and Human Behavior at University of California, Los Angeles, USA, is conducting a neuroimaging study to determine the effects of SK&P on the brain's emotional response. The investigators are also examining the effects of the Youth Empowerment Seminar (YES!) (a program for teenagers which includes training in SK&P) on measures of emotional well-being in high school students. Preliminary results indicate that the YES! reduces impulsiveness, a tendency that leads to risky behavior, such as drug abuse.

Investigators affiliated with Stanford University School of Medicine and Florida International University, USA, are conducting two programs. The first is a study on YES!. The findings suggest that YES! may be effective in reducing risk factors for substance abuse, aggression, and academic failure and for supporting developmental assets; these are characteristics that enable youth to thrive and become contributing members of society. Expected completion date of this project is the end of 2011. The second study is on the efficacy of the Art of Living for Educators program (which is a modified SK&P program) on improving teacher excellence and reducing teacher burnout. Preliminary results suggest that the program may significantly reduce stress and increase quality of life. The expected completion date is end of 2011.

A qualitative study at Laurentian University's School of Rural and Northern Health in Ontario, Canada, compares SK&P with mindfulness meditation in the treatment of substance use and mental health disorders including depression, anxiety, and PTSD. A preliminary analysis of the data suggests that while there are many shared characteristics between SK&P and Mindfulness Meditation, in that they both utilize the breath as an "anchor to the present moment", SK&P appears to add a strong additional dimension to the treatment of both mental health and substance use disorders.

Conclusions

The subjective reports of increased health, vitality, well-being, and peace of mind by tens of thousands of SK&P practitioners are consistent with research findings: Studies suggest an overall strengthening of the mind-body system. EEG, blood cortisol, and lactate levels reflect a state of relaxation, yet alertness. Significant increases in NK cells and antioxidant enzymes suggest that regular practice may help prevent many serious diseases. Robust effects on PTSD and depression symptoms indicate that SK&P relieves psychological distress. Measurable changes at the level of gene expression suggest that the effects of SK&P span all levels of the physiology, from molecular to organ systems.

Thus, even though further studies are certainly needed, these findings point to the powerful health restoration and promotion effects of these time-honored practices that can be employed to increase wellness in healthy people and used as adjunct tools in therapy.

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The Art of Living Foundation, founded by Sri Sri Ravi Shankar, is a non-profit educational and humanitarian organisation, and a Non-Governmental Organisation of the United Nations in special consultative status with the UN's Economic and Social Council.

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