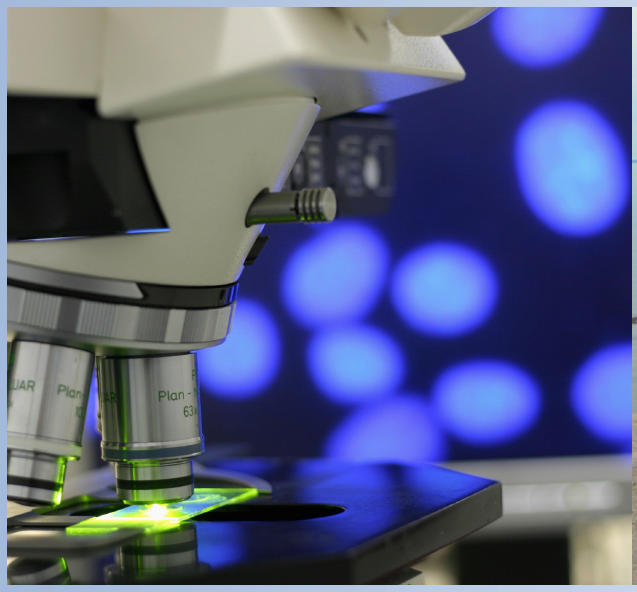
THE ART OF LIVING

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.

Background

Health and wellness are more than the mere absence of illness. They reflect thriving physically, emotionally, and psychologically. One of the most important determinants of wellness is often overlooked: the stress levels in our lives. Chronic stress can break down the smooth interactions in our mind-body complex and negatively affect every aspect of our health and well-being.

A rapidly growing body of research now robustly links our emotional states to our physiological status, and to our ability to fight or succumb to a broad spectrum of diseases. These include both simple diseases like the common cold, as well as chronic and life-threatening ailments ranging from cancer to coronary heart disease, asthma and HIV-1 infection.

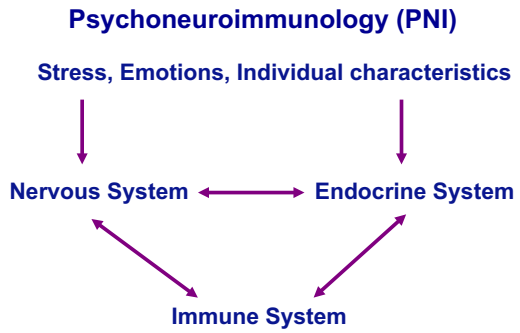


Figure 1. Large body of psychoneuroimmunology (PNI) research has shown that our thoughts and emotions can powerfully affect the brain, endocrine, and immune system function.

How can psychological and behavioural factors affect our physiology and overall well-being so dramatically? Cutting edge science in the field of psychoneuroimmunology (PNI) has shown that our thoughts and emotions can powerfully affect the brain, endocrine (hormone), and immune system function (Figure 1). When we are stressed, specific hormones are secreted which may have beneficial effects in the short term, but if sustained for longer periods of time, suppress the immune system. For example, during the stress of final exams, the activity of disease fighting cytotoxic T-cells (a specialized immune cell) in medical students is decreased 25-fold (Figure 2). Under such conditions of suppressed immune function it is much easier for bacteria, viruses, and cancer cells, to thrive in our body. As a result, we get sick.

Conversely, "positive" emotions, such as joy, love, and enthusiasm, produce chemical messengers that can affect the brain, endocrine, and immune systems in positive ways, resulting in improved resistance to disease and better overall health. Current PNI research also confirms that psychological and immunological functioning can be enhanced through certain stress management programs. One such

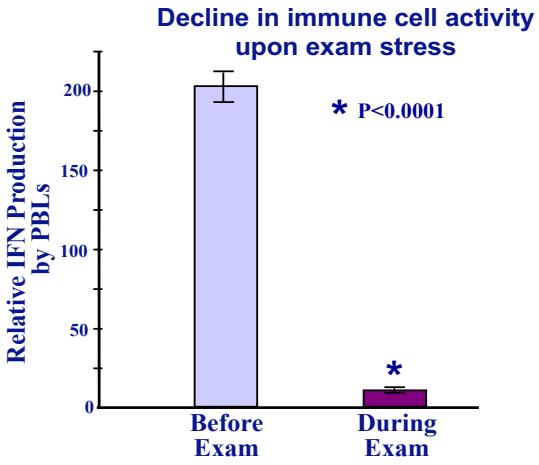


Figure 2. The activity of disease fighting immune cells in medical students is decreased 25-fold under exam stress.

program that is gaining interest in the medical community 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 in 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, thus supporting the whole mind-body system.

SK and its accompanying practices, SK Yoga (SKY), has 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 studies.

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 and autonomic nervous system function (increases mental focus, calmness & recovery from stressful stimuli)
- Enhance health, well-being, emotional regulation & peace of mind
- Relieve Post Traumatic Stress Disorder (PTSD) symptoms
- Affect the mind-body system at the molecular level

Research Summary

Improved wellness parameters

To assess the potential increase in wellness in healthy individuals, Swedish adults were assigned to practice either SKY or to relax in an armchair daily for six weeks. Participants in the SKY group, but not the control group, demonstrated significant increases in levels of optimism, as well as significant reductions in anxiety, depression, and stress (e.g. Figure 3).

Researchers at the University of Wisconsin Center for Investigating Healthy Minds, and the think tank Research Triangle Institute (RTI) conducted two parallel studies of emotional well-being and emotion regulation in young adults. The participants in both studies were instructed in SKY and encouraged to practice daily at home. Using standardized measures, the RTI study documented significant improvements in positive affect including increased happiness, energy, joy, creativity and serenity, and decreased sadness and fatigue when tested one month post workshop. The University of Wisconsin study demonstrated significant improvements in life satisfaction and social connectedness, as well as significant declines in depression and perceived stress both one week and one month after learning SKY. This suggests that within a short time span greater levels of emotional well-being and life satisfaction are associated with regular practice of SKY.

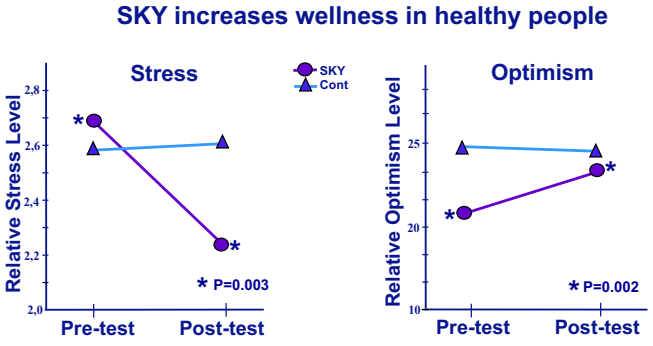


Figure 3. SKY significantly decreased stress and increased degree of optimism in healthy adults, indicating improvement of wellness.

Relief from Depression

According to an EU Commission publication, 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. Thus, new strategies for fighting depression and anxiety are urgently needed.

Several independent studies have shown that SKY practitioners experience a 68%–73% success rate in the treatment of clinical depression, regardless of severity. Relief from depression, determined by psychiatric evaluation and standard psychiatric measures was experienced within a few weeks (e.g. Figure 4). At the three-month follow-ups, patients remained stable and in remission. Published studies further suggest that SKY normalises patients' brainwave patterns and is as effective as standard anti-depressant drug regimens. Yet it is safe, free of unwanted side effects, cost-effective, and self-empowering.

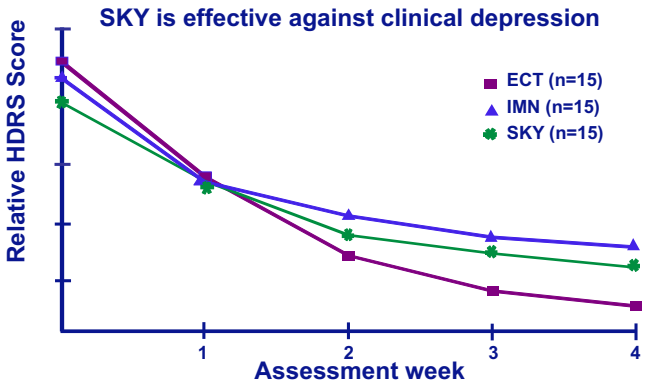


Figure 4. SKY significantly reduced clinical depression within a few weeks. HDRS, Hamilton Depression Rating Scale; ECT, electroconvulsive therapy; IMN, imipramine (drug).

Independent studies have also shown significant reductions in both clinical and non-clinical anxiety. An open trial of patients with Generalized Anxiety Disorder who had not responded to prescription medication showed a 73% response rate (HAM-A) after four weeks practice of SKY. Furthermore, a study of apparently healthy adults showed significant reductions in anxiety (STAI) in four weeks.

Italian scientists in the Department of Neurosciences, Fatebenefratelli Hospital in Milan, studied 69 patients with clinical depression and/or anxiety who had not achieved adequate response after 6 months of standard pharmacotherapy. Patients were randomized to continue treatment as usual (TAU), or to add to TAU a 10-day SKY training and then practice SKY daily. Two weeks later, all five standardized psychiatric measures demonstrated significant reductions in both depression and anxiety in the SKY, but not the TAU group, which were sustained at, 3 and 6 months. Among SKY group participants, 98% of those with clinical anxiety and 80% of those with clinical depression achieved remission. The improvements in the SKY group were equal among SKY participants who discontinued medication as well as those who continued on medication, suggesting that the improvements were mediated by SKY. These findings suggest that SKY can be considered as a self-empowering, cost effective adjunctive, or in specific cases an alternative method, for treating anxiety disorders and melancholic depression.

Researchers at the Department of Psychiatry, University of Pennsylvania, USA, evaluated SKY as an adjunct intervention in patients (n=25) with major depressive disorder (MDD) who had not adequately responded to antidepressant treatment. This randomized, waitlist-controlled pilot study found significant reductions in the SKY participants, but not the controls, demonstrating that an adjunctive SKY-based intervention for patients with MDD is both feasible and clinically effective.

Relief From Post-Traumatic Stress Disorder (PTSD)

Traumatic events, such as natural or man-made disasters, can induce high rates of psychiatric illness, including PTSD, depression and suicidal tendencies. A study of 183 survivors of the 2004 Tsunami living in refugee camps tested the effects of a modified SKY program (referred here as SKY) or followed by a trauma reduction exposure technique (TIR) on PTSD and depression. Subjects had PTSD according to standard measures were assigned to one of three groups: SKY, SKY+TIR or 6-week wait list (controls). Measures for PTSD and depression 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) in the SKY group with no significant change in the controls (Figure 5). The addition of TIR did not improve results obtained by SKY alone. These results suggest that SKY helps relieve psychological distress following mass disasters.

Researchers at Stanford University and University of Wisconsin-Madison, USA, studied Iraq and Afghanistan war veterans to assess the potential effect of SKY on PTSD that is very common in this population. US male veterans (n=21) were randomized to either an experimental group or wait-listed control group. They were measured before the intervention, as well as one and twelve months afterwards. There was a significant reduction in PTSD symptoms, anxiety, and respiration rate in the experimental arm, but not in the control group. This longitudinal intervention study suggests that there may be clinical utility for SKY for PTSD.

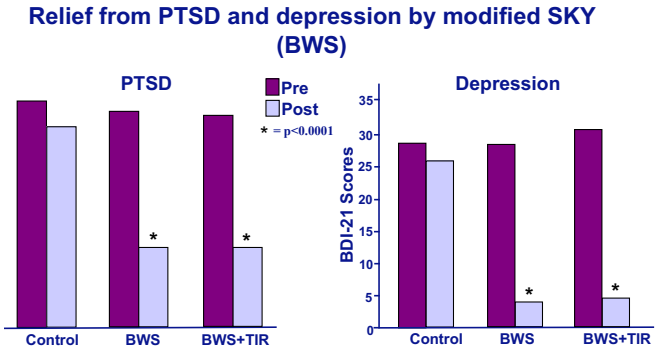


Figure 5. A modified form of SKY (BWS) either alone or in combination with a trauma reduction program (TIR) was tested on survivors of the 2004 tsunami. These data suggest that SKY effectively relieves both PTSD and depression symptoms, regardless of TIR.

Enhanced Emotional regulation

Difficulties regulating emotional responses to events in our lives plays a critical role in mood, anxiety, and personality disorders. The ability to calm strong emo¬tional reactions by mentally reframing the meaning of events (called cognitive reappraisal) was studied in SKY practitioners and controls at the Erasmus University Rotterdam, The Netherlands. While initially both groups successfully reduced their negative feelings, neurophysiological correlates captured by EEG recordings found that the effect of reappraisal persisted longer in the SKY group. This indicates that SKY can help regulate the emotional response and thus promote psychological wellness.

Department of Psychiatry and Behavioral Sciences at the University of California, Los Angeles, USA, examined the effect of the Youth Empowerment Seminar (YES!) (which includes training in SKY) on impulsivity, a measure of emotion regulation in high school students (n=788). YES! significantly reduced impulsivity, a trait that can lead to risky health behaviors, such as violence and substance abuse. The results suggest that YES! can promote mental health in adolescents, potentially protecting them from harmful coping behaviors.

Significant improvements in multiple aspects of emotion regulation were also documented in young adults in the RTI study (cited above) at one month post workshop. In addition, physiological correlates of improved emotion regulation (Heart Rate Variability – HRV) increased at 1-month follow-up. These findings suggest that SKY may provide easily adopted self-empowering tools for enhancing physical and emotional well-being in young adults.

Effect on Cortisol, the "Stress Hormone"

Several studies have demonstrated significant declines in cortisol levels following regular practice of SKY. In one study, experienced SKY practitioners (Group 1) were compared with beginning practitioners during their first SKY session (Group 2), and also before learning SKY, while listening to classical music (Group 3). Among beginners, the fall in cortisol levels was significantly greater during SKY than when listening to classical music, suggesting that SKY produces a better relaxation response. In addition, experienced SKY practitioners had significantly lower blood cortisol levels before the start of the

SKY session than the beginning practitioners. This indicates that the experienced practitioners incur less stress under the demands of daily living. Following the SKY session both beginning and experienced practitioners demonstrated further significant declines in cortisol levels that regular practice of SKY develops progressively greater levels of both relaxation and resilience to stress.

Effect on Blood Lactate

Blood lactate is another biochemical measure of stress that has been shown to increase under extended psychological stress. Police cadets constitute a highly stressed group who undergo intense physical and emotional training daily. All India Institute of Medical Sciences, New Delhi, India, conducted a study where some trainees were assigned to learn and regularly practice SKY while others served as controls. After five months blood was drawn before and after the SKY practice to determine lactate levels. Before the practice (basal levels), the blood lactate in SKY practitioners were four times lower than that of controls (Figure 6). After a session of SKY, there was a further significant drop in blood lactate levels in the SKY group, whereas no changes were observed in the control group. These results indicate that SKY induces a state of relaxation.

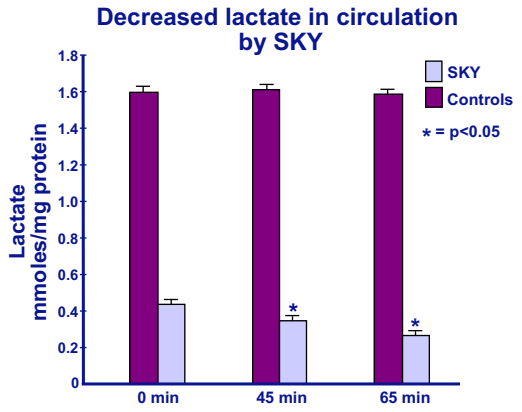


Figure 6. SKY significantly decreased Lactate (an indicator of tension and stress) in the blood of police trainees. Note the significantly lower level before SKY that is further decreased upon practice.

Effect on Antioxidant Enzymes

Repeated exposure to environmental pollutants and metabolic byproducts result in the formation of free radicals, which contribute to many diseases (including cancer and cardiovascular disease) and the aging process. To counteract free radicals, the human body has a powerful internal defense system in the form of antioxidant enzymes. A study to assess the effect of SKY on antioxidant enzymes was conducted on the same group of police trainees as above. The levels of three major antioxidant enzymes – superoxide dismutase (SOD), catalase, and glutathione was significantly higher in SKY practitioners than in the control group after five months of baseline measurement (Figure 7). There was an additional increase in all enzymes after practice of SKY with no significant change in the control group. These data suggest that people who practice SKY have an improved antioxidant status and thus an enhanced defense against free radical damage.

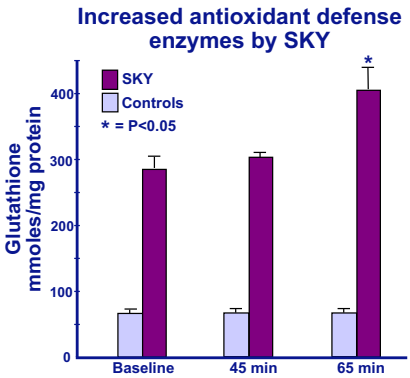


Figure 7. Increased antioxidant enzyme glutathione by SKY practice. Note the significantly higher level before SKY that is further increased upon practice.

Effect on Lipid Profile

Stress is known to be a significant contributor to elevated cholesterol levels. A randomized study of engineering students during two periods of exam stress demonstrated significantly lower levels of total cholesterol, low density lipoproteins (LDL or 'bad' cholesterol), and triglyceride levels in SKY practitioners than in controls after each exam. Prior to exams there were no significant differences in the cholesterol profiles of the two groups, suggesting that practice of SKY may play a significant role in promoting a favorable lipid profile and thus cardiovascular health.

Effect on Immune Function

Natural killer (NK) cells are the surveillance cells of the immune system capable of destroying tumor cells and infected cells. The effect of SKY on NK cells was studied on three groups: SKY practitioners, normal individuals not practicing SKY, and cancer patients in remission. NK cells were significantly higher in the SKY group than in either non-practicing individuals or in cancer patients in remission (Figure 8). The cancer patients then learned SKY. After 12 and 24 weeks of regular practice, there was a significant increase in the NK cell count of cancer patients in remission who practiced SKY compared with a control group of remitting cancer patients who did not practice SKY (Figure 8). This is particularly encouraging since cancer survivors have abnormally low levels of NK cells, which have an important role in the body's defense against new and recurring cancers.

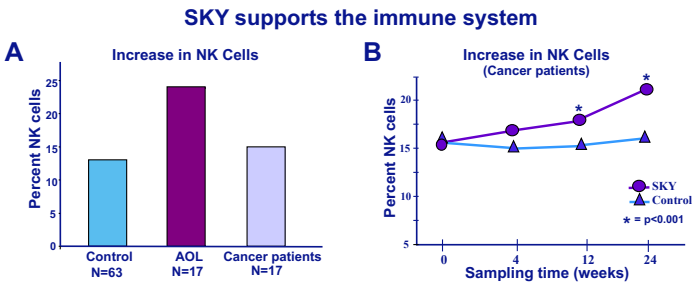


Figure 8. A) NK cell levels in blood were compared in normal controls, normal SKY practitioners, and cancer patients. B) Cancer patients learned SKY or were left as controls, and NK cell levels were determined at indicated time points.

Improved Brain Function

To study the long-term effects of SKY on brain function, EEG (electroencephalogram) changes were recorded in 19 SKY practitioners outside of the practice of SKY, and compared with EEG patterns of 16 controls (doctors and researchers who did not practice SKY, yoga, or meditation). There was significant increases in beta activity in the left frontal, occipital, and midline regions of the brain in the SKY practitioners, as compared to controls (Figure 9). These results are interpreted by neurologists as indicative of increased mental focus/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.

EEG activity was also studied during the practice of SKY 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.

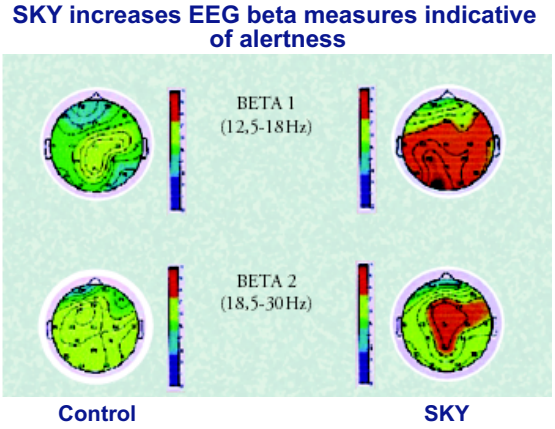


Figure 9. Significant increases in beta activity were observed in the left frontal, occipital, and midline regions of the brain in the SKY practitioners, as compared to controls ($p<0.05$).

Improved Autonomic Nervous System (ANS) Function

The autonomic nervous system innervates every organ and system in the body. It has two primary branches: the sympathetic nervous system which is activated under stress (the 'fight or flight' response), and the peaceful parasympathetic nervous system which is activated when we are relaxed and rested ('rest and digest' response). These two systems complement each other: as one increases the other decreases. SKY has been shown to be a potent tool for reducing sympathetic and simultaneously increasing parasympathetic drive, restoring a more optimal balanced state. This in turn benefits the entire mind/body complex.

In the study at Fatebenefratelli Hospital in Milan, introduced above, cardiological and respiratory states were also tested using Respiratory Sinus Arrythmia (RSA), a naturally occurring variation in heart rate that occurs during the breathing cycle. RSA serves as a measure of parasympathetic nervous system activity. SKY significantly reduced anxiety and depression and the improvement was sustained after six months. In addition, sympathetic modulation and cardiac autonomic control were significantly lower while parasympathetic modulation and cardiorespiratory coupling were significantly higher in the SKY group compared to control group. These findings suggest that SKY may be a useful non-pharmacological intervention to improve symptoms and reduce cardiovascular risk in patients with anxiety/depression disorders.

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.

Based on the wide array of SKY on various physiological parameters, it was hypothesized that it may have effects at the molecular level, on the level of DNA. One study assessed 42 SKY practitioners and 42 non-practitioners. Antioxidant enzyme levels in the blood were compared with their gene expression levels in circulating immune cells. There was a bet–ter antioxidant status both at the enzyme level, and corresponding gene expression patterns, in immune cells of SKY practitioners. This is consistent with results summarized above and suggests that the effects of SKY on antioxidant enzymes are due, at least in part, to changes in gene expression.

In another study, short term (within two hours) global changes (for all of the genes in the DNA) in gene expression were investigated upon SKY practice in 10 subjects. Blood was drawn immediately before and after SKY (on two separate occasions), or a control regimen of nature walk plus listening to classical music (also on two separate occasions in the same subjects). Gene expression profiles in circulating immune cells were determined. There were changes to the expression of about four times more genes by SKY compared with the control regimen (Figure 10). Most of the differentially expressed genes in response to SKY were distinct from the control regimen and belonged to different gene families. These findings suggest that the beneficial effects of SKY on different levels of the physiology are mediated by molecular events.

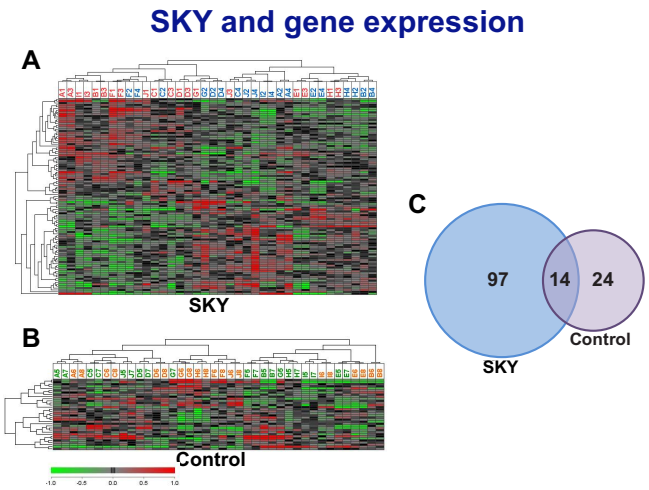


Figure 10. Rapid effects of SKY on global gene expression profile in healthy subjects. A) SKY effects. B) Control regimen effects. C) Venn diagram showing the number of genes regulated by SKY and control, and their intersection. See Qu et al. 2013 for more information.

Conclusions

The subjective reports of increased health, vitality, well-being, and peace of mind by hundreds of thousands of SKY 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, anxiety and depression symptoms indicate that SKY relieves psychological distress. Measurable changes at the level of gene expression suggest that the effects of SKY 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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