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Meditation, Taijiquan and Qigong

Evidence for Their Impact on Health and Longevity

DONALD D. DAVIS

Abstract

This paper examines the effects of meditation, mindfulness, taijiquan, and qigong. I review the most recent and rigorous scientific research to document the impact of these practices on outcomes commonly sought by Daoist practitioners: health and longevity. I discuss the apparent pathways through which these practices achieve their effects, and conclude with recommendations for practice to enhance the likelihood that the potential benefits of these practices are successfully achieved.

Daoists throughout history have practiced self-cultivation in pursuit of health and longevity. A plethora of practices have been used to enable this pursuit, but foremost among them is meditation, for example, *zuowang*—sitting and forgetting. Daoists have frequently practiced physical movements such as taijiquan and qigong that also cultivate the state of mindfulness produced by meditation. Daoist organizations may use taijiquan and qigong to recruit and train new members and to serve their local communities, for example, Daoist Association USA (www.daousa.org), U. S. Taoist Association (<http://ustaoistassoc.com/>), Taoist Tai Chi Society (www.taoist.org), and the British Taoist Association (www.taoists.co.uk).

These practices provide a gateway for many to discover Daoist ideas, for example, *ziran*, *wuwei* and the energetic integration of body and mind, while improving their health and well being. Interested students

may go on to explore Daoist texts and learn Daoist forms of meditation and other practices. In time, they may join Daoist organizations and enter a lineage, or they may begin a lifelong practice as a non-religious Daoist. Of course, merely practicing meditation, taijiquan or qigong does not make one a Daoist, and many Daoists may not practice taijiquan or qigong.

Countless meditation practices exist. Despite differences in appearance and method, they share similar purposes, functions and effects. The differences they present are chiefly a result of the cultural and historical context in which they were created and practiced. At root they are similar, and they take one to the same destination (Kohn 2008).

Practices of Self-Cultivation

Meditation is the foundation of self-cultivation. Mindfulness is a state of mind produced by meditation as well as an approach to meditation that produces this state of mind. Meditation is typically practiced while one sits and remains physically still, but it may also be practiced while standing, walking, lying down, or while engaged in daily tasks. Taijiquan and qigong are moving forms of meditation; attention is trained, as in sitting meditation, while one pursues self-cultivation alone or with a partner. Taijiquan incorporates Daoist principles that are adapted to daily life, for example, the management of contradiction and conflict. Although many teachers emphasize the martial and health applications of taijiquan, it can be a powerful means for self-cultivation when practiced with this aim in mind.

Meditation, taijiquan and qigong employ three forms of mental training. In *focused attention*, one directs the attention to some target and sustains this focus, for example, a physiological process such as breathing, a sensation in the body such as tightness or balance, an object or sound, or a physical activity such as pulling weeds. *Intentional awareness* is a special application of focused attention where the mind employs an intention to guide attention and awareness, for example, visualization of internal energy states or substituting positive emotions for negative emotions. The attention is directed to create desired outcomes and hence is more instrumental than focused attention.

In *open awareness*, the mind attends to sensations and thoughts as they emerge and disappear without employing the intellect. Open awareness focuses attention on experience in the present moment without analysis and judgment. This approach defines the state of mindfulness as well as the meditation method used to produce it; many refer to this practice as mindfulness meditation. Researchers have most often studied this approach to meditation.

Some practices employ multiple forms of mental training. For example, focused attention may be combined with intentional awareness when directed to different parts of the body and its processes as in many internal alchemy practices. In the solo practice of taijiquan, focused attention may be used to isolate and remove tension in specific areas of the body or to align one's posture with a principle such as separation of yin and yang. Open awareness may be used to sense the mind and body while they move. Intentional awareness may be used to refine a specific principle such as controlling one's steps and shifting the body's weight while moving. In push hands (*tuishou*), taijiquan practice with a partner, one must integrate and rapidly move between focused attention, open awareness, and intentional awareness.

As discussed below, there is some evidence that the mental focus one uses may achieve different effects and may operate through different mechanisms, for example, focused attention seems to engage different areas of the brain than open awareness forms of meditation. Taijiquan and qigong, which combine all three forms of awareness with body movement, may stimulate broader neural integration than sitting meditation, but research has not documented this outcome. We discuss this more below.

Students may be exposed first to a more popular practice, such as taijiquan, and later become acquainted with various meditation practices. With the right teacher, students may learn about self-cultivation and the Daoist roots of taijiquan and some qigong practices, and then go on to explore the Daoist literature. Self-development through these experiences is seldom linear and, instead, more closely resembles movement through a labyrinth. When walking the labyrinth, one moves through a series of intricate and winding paths from a position outside the circle, finally to arrive at circle's center, the source of its spiritual power.

Michael Rinaldini illustrates this winding path of self-cultivation toward his own center (2008). He first encountered Daoist principles through acupuncture and qigong treatment to address health concerns, which led to study of qigong and Daoism, which led several years later to being ordained as a Daoist priest in the Longmen tradition. Now he trains Daoist priests in the United States. Daoist meditation (*zuowang*) is the core of the practice he teaches, accompanied by instruction in qigong and Daoist texts.

Taijiquan is the physical embodiment of Daoist principles and their manifestation in daily life. Moreover, like some types of qigong, it provides a powerful entry point to the mind for those who have difficulty accessing it through long periods of motionless sitting required of many meditation traditions. When practiced properly under the guidance of a knowledgeable teacher, meditation, taijiquan and qigong converge on the same point; they each lead to the center of the labyrinth.

Many, perhaps most, of those who meditate or practice taijiquan and qigong are unaware of the Daoist influence on the arts they practice, and they have no desire to learn about Daoism. Some may even chafe at attempts to emphasize the Daoist connection. I've had several students who were devout members of religious faiths who preferred not to learn about the Daoist principles embedded in meditation, taijiquan and qigong although they practiced these diligently.

Ultimately it doesn't matter. One achieves the results from these practices that one seeks—health and longevity, peace and tranquility, positive relationships, spiritual growth, or all of the above. One achieves these effects whether or not one understands the cultural origins of the practice or its mechanism of action so long as the teaching they receive is authentic and they practice with patience and persistence. This is because these practices operate simultaneously on the mind and body; they achieve their effects through mental and physical systems shared by all humans around the world. In the next section, I summarize the evidence demonstrating the impact of these practices on health and longevity. In the final section, I explain how these practices achieve their effects and the implication of this for practice.

Impact on Mind and Health

Thousands of research studies have examined the impact of meditation, taijiquan, qigong and the mental states that they produce on many indicators of mental and physical health and longevity. Additionally, researchers have begun to explore the underlying mechanisms that may explain their influence. One's personal experience with these practices is often sufficient to document their effectiveness—one's balance improves, chronic illnesses are relieved or healed, positive emotions replace negative emotions. Like with any new health practice, research evidence is an important external source of validation that may encourage the practice of meditation, taijiquan and qigong among those who are unfamiliar with them or skeptical about their claims. I have received numerous referrals from physicians who have been persuaded by research evidence that these practices are beneficial rather than by their personal experience with them.

Research examining these practices has also been criticized. Researchers often fail to consider the cultural context of these practices when they study them and may strip out essential components when they test them. Researchers may not include highly experienced practitioners in the design and implementation of their studies. Small sample sizes and idiosyncratic implementations of a practice make it difficult to detect effects if they exist. Little attention is paid to differences in taijiquan and qigong practices and the manner in which they can be taught. Researchers often fail to understand differences in these practices and treat them interchangeably, for example, a researcher may not identify the specific style of taijiquan or qigong that was tested. Because of flaws such as these, it is difficult to draw confident conclusions from single research studies.

Rather than emphasize single research studies, I relied on reviews that employed meta-analysis, which is a statistical technique used to aggregate results across numerous studies. Meta-analysis, the gold standard for research literature reviews, estimates overall effects after controlling for errors due to small sample size, poor measurement and other weaknesses in research design and methods. The estimated effect sizes are believed to represent more closely "true" outcomes than effects reported in any single research study. Meta-analysis allows one to draw

conclusions with much greater confidence than can be drawn from any single study.

I also focused on studies that examined each practice by itself rather than combined it with other practices so that I could draw clear conclusions about the impact of each practice. With one exception (Mindfulness Based Stress Reduction, MBSR), I excluded studies that combined meditation or mindfulness training with other components, such as psychotherapy or physical therapy.

This exclusion means that I do not discuss some successful uses of interventions in which meditation is one of several components, for example, treatment of substance use and addiction, trauma recovery, and other psychological disorders (Creswell 2017). Finally, I emphasized results from randomized controlled trials (RCTs) in which participants were randomly assigned to receive meditation, taijiquan or qigong training or to a control group that may have received treatment as usual, placebo treatments, or no treatment at all. My emphasis on meta-analysis and RCTs yields the greatest confidence concerning scientific support for these mindfulness practices.

One of the earliest and most robust examinations of meditation as a health treatment focused on its ability to alleviate stress and reduce chronic pain for patients for whom usual medical treatment was ineffective (Kabat-Zinn 1982). Mindfulness meditation, which employed focused awareness and open awareness forms of meditation to scan the body and focus on the breath, relaxation, perceptions of pain and reactions to it, was combined with practice of hatha yoga postures to develop the state of mindfulness through movement.

Mindfulness was also encouraged during walking, standing and eating. Participants practiced in groups and at home for eight weeks and were provided instructional materials to calibrate expectations and to explain the relationship between stress and illness and how meditation could heal their chronic pain and enhance their health. Significant decreases in numerous measures of pain and other health symptoms were observed in more than half of the meditating participants.

Subsequent studies employing more rigorous research designs confirmed these results and showed participants continued to demonstrate improved pain management and sustained their meditation practice for up to four years after the training ended (Kabat-Zinn et al. 1985; 1986).

These studies stimulated numerous attempts to examine the impact of MBSR and similar approaches to mindfulness meditation on many types of physical and mental illness as well as its impact on healthy individuals that do not report symptoms of illness. MBSR is the most documented application of meditation in health care.

Recent reviews have shown that MBSR has been effective in reducing anxiety, depression, and feelings of distress and burnout alone as well as when they accompany chronic pain, cardiovascular disease, and chronic somatic diseases such as fibromyalgia (Gotink et al. 2015; Khoury et al. 2015). MBSR has become a model of applying meditation to the treatment of physical and mental illness and has inspired integration of meditation with other forms of treatment such as psychotherapy.

This record of effectiveness has inspired researchers to study the impact of meditation and meditative movement practices such as taijiquan, qigong and yoga on many indicators of health and longevity and to speculate about their causal mechanisms. I review these studies next sorted into the physical and mental conditions they address. I emphasize reviews that have been published recently in peer-reviewed journals.

Specific Conditions

ARTHRITIS: Taijiquan practice has been shown to produce small to moderate improvements in stiffness, pain and fatigue, physical functioning, bone growth, and connective tissue for patients with rheumatoid arthritis and osteoarthritis (especially of the knee), and as well as improvement in related psychological well being and quality of life (Wang 2011; Chen et al. 2016).

BONE DENSITY: Taijiquan has been shown to increase bone mineral density at the lumbar spine, femur neck, femur trochanter, and total hip among older adults, perimenopausal and postmenopausal women, people with osteoarthritis, and cancer survivors (Zou et al. 2017).

BRAIN FUNCTION: Numerous studies of meditation show that it alters brain structure and function due to the brain's neuroplasticity—changes that occur in response to experience—which can include growth of new connections and creation of new neurons (Davidson and Lutz 2007). Meditation increases gray matter volume and alters at least eight regions of the brain, including those regions devoted to meta-awareness

(frontopolar cortex/BA 10), exteroceptive and interoceptive body awareness (sensory cortices and insula), memory consolidation and reconsolidation (hippocampus), self and emotion regulation (anterior and mid-cingulate; orbitofrontal cortex), and intra- and inter-hemispheric communication (superior longitudinal fasciculus; corpus callosum) (Fox et al. 2014).

Different areas of the brain activate or deactivate depending on whether focused attention, open awareness, compassion/lovingkindness, or mantra types of meditation are employed (Boccia et al. 2016). Brain network integration is higher among experienced meditators compared to novices, which indicates the influence of practice and experience (van Lutterveld et al. 2017).

CANCER: Research examining meditation in cancer has focused more on complex interventions comprised of meditation combined with multiple therapeutic components, such as MBSR and mindfulness-based cognitive therapy, than on the impact of meditation alone. Reviews of these interventions reveal that they alleviate symptoms that accompany cancer treatment, for example, depression and anxiety, and improve physical functioning and quality of life (Gotink et al. 2015).

It is impossible to estimate the extent to which meditation or other components of the intervention are responsible for these effects. Nevertheless, these interventions appear to produce the same changes in brain structure and function produced by long-term meditation practice, which suggests that the meditation component of these interventions and the state of mindfulness that it produces exerts a strong influence on outcomes (Gotink et al. 2016).

Taijiquan and qigong have been shown to be effective in reducing multiple effects of cancer and its treatment, such as fatigue, sleep disturbance, shortness of breath, strength, anxiety, depression, and quality of life (Vu et al. 2014). Among cancer survivors, 75% of whom were women, taijiquan and qigong improved fatigue, sleep difficulty, symptom depression, and quality of life (Wayne et al. in press).

CARDIOVASCULAR: Mindfulness practices enhance numerous indicators of cardiovascular health in healthy adults and those with cardiovascular disease. Meditation has been shown to reduce diastolic and systolic blood pressure (Shi et al. 2017). Taijiquan and qigong have been shown to improve total cholesterol, low-density cholesterol, high-density

cholesterol, and triglycerides (Hartley et al. 2014) and improve diastolic and systolic pressure among those with stroke risk factors (Lauche et al. 2017; Yang, Wu, and Wang 2017) and in patients with cardiovascular disease (Wang et al. 2016).

Taijiquan practice has been shown to improve cardiorespiratory fitness among healthy adults (Zheng et al. 2015) and to enhance left ventricular ejection fraction and B-type natriuretic peptide, a hormone related to regulation of blood pressure among patients with chronic heart failure (Gu et al. 2017). Taijiquan also enhanced vagal modulation and improved heart rate and heart rate variability in patients with coronary heart disease (Chang et al. 2008). This influence on vagal response demonstrates the ability of taijiquan to influence autonomic nervous system responsiveness, which, as we discuss below, may explain how mindfulness practices enhance physical and mental health and longevity.

Qigong when used alone has also been shown to reduce diastolic and systolic blood pressure and, when combined with anti-hypertensive drugs, has been shown to reduce diastolic and systolic blood pressure more than use of anti-hypertensive drugs used alone (Xiong et al. 2015). Baduanjin or Eight Brocades qigong has been shown to improve diastolic and systolic blood pressure, resting heart rate, and trunk flexibility (Zou et al. 2017).

COGNITION: Both focused attention and open awareness meditation have been shown to have a significant positive influence on perception, attention, intelligence, learning and memory, and the cognitive control required to manage emotions beyond that observed with mere relaxation training or no treatment (Eberth and Sedlmeier 2012; Sedlmeier et al. 2012; Sedlmeier, Lobe, and Quasten, in press).

Among those aged 60 and over, taijiquan has been shown to improve cognitive function as measured with multiple neuropsychological tests. Strongest improvement was seen for executive function (processing speed, attention, and working memory) in those without significant preexisting impairment; those who were cognitively impaired experienced smaller gains (Wayne et al. 2014).

EMOTION REGULATION: Meditation has been shown to increase positive emotions and decrease negative emotions as well as improve the ability to manage their expression. Meditation practiced to cultivate kindness and compassion has been found to increase mindfulness, com-

passion toward oneself and others and decrease symptoms of depression (Galante et al. 2014). Practitioners also report improvement in positive and negative emotions, psychological distress, positive thinking, interpersonal relationships, and empathy (Shonin et al. 2015).

FALLS AND FALLING: Taijiquan practice reduces the likelihood of falling and being injured from falls among older adults (Lomas-Vega et al. 2017). This result is due in part to increased bone density and enhanced body perception, as discussed above. These positive effects increased with practice frequency. Practice of the Yang style may provide more benefits than practice of the Sun style of taijiquan (Huang et al 2017).

FATIGUE: Taijiquan has been found to reduce fatigue and improve vitality more than conventional therapy (Xiang, Lu, Chen, Wen 2017).

INFLAMMATION: Inflammatory processes are thought to play a role in many health conditions such as fatigue, pain, artery and heart disease, diabetes, and negative emotions such as depression. Chronic inflammation is associated with the aging process and reduces longevity.

Bower and Irwin (2016) describe the impact of taijiquan and qigong on circulating, cellular, and genomic markers of inflammation and provide a model that may explain the causal process underlying the link between mind-body practices such as these and inflammatory biology. Their review revealed mixed results for circulating inflammatory markers (C-reactive protein, interleukin-6, and cytokine production).

More consistent findings were shown for decreased expression of inflammation-related genes and reduced signaling through proinflammatory transcription factor NF- κ B. Taijiquan and qigong seem to enhance longevity through their ability to reduce inflammation throughout the body. We discuss this potential causal mechanism more below.

LONGEVITY: Daoists have pursued longevity for millennia. Meditation, taijiquan and qigong contribute to longevity by reducing the impact of numerous diseases and chronic conditions. By reducing inflammation, these practices also enhance telomerase activity. Telomerase is an enzyme that influences the length of telomeres, which are proteins that protect the end of chromosomes. Telomerase activity and telomere length are associated with health and longevity. Chronic stress and depression reduce telomerase activity and shorten telomeres. Shortened telomeres are associated with aging, poor health and mortality.

Mindfulness meditation is positively associated with increases in telomerase activity (Schutte and Malouff 2014). Qigong and other forms of exercise also increase telomerase activity (Deng et al. 2016). Kurth, Cherbuin, and Luders (2017) describe how meditation can enhance telomerase activity, slow down aging of the brain and increase longevity.

MEDITATION RETREATS: Multi-day retreats are a common method for providing meditation training. Khoury et al. (2016) summarize the nearly two-dozen studies that examine their impact. They report that meditation retreats have large effects on reducing anxiety, depression and stress. They have more moderate effects on enhancing emotion regulation and quality of life. These effects are achieved through increased mindfulness, compassion and acceptance.

MULTIPLE SCLEROSIS: Multiple sclerosis (MS) is a chronic disease that affects the brain and spinal cord. For unknown reasons, the immune system attacks the protective sheath that covers nerve fibers, which disrupts the ability of the nervous system to operate. Over time, the nervous system becomes permanently damaged. Taijiquan has been shown to improve MS symptoms. Taijiquan practice improved balance, gait, flexibility, and leg strength, and reduced pain, fatigue and depression, and produced higher quality of life among those with MS (Taylor and Taylor-Piliae 2017; Zou et al. 2017).

PAIN: Pain management was the first focus of treatment for meditation. Meditation and meditative physical movement (yoga) are important elements in MBSR, which has been shown to be effective in reducing pain symptoms and comorbid conditions such as depression as well as numerous other chronic medical and psychological conditions (Hilton et al. 2017). Taijiquan has also been shown to reduce chronic pain associated with osteoarthritis and osteoporosis as well as lower back pain (Kong et al. 2016). Some studies have shown that external qigong (external qi healing) may reduce chronic pain (Lee, Pittler, and Ernst 2007)

PARKINSONS DISEASE: Parkinson's disease (PD) is a chronic neurological disorder that affects the brain. Symptoms include tremors, difficult movement and gait and balance problems. Its causes are unknown, and there is no cure. Taijiquan and qigong have been shown to improve motor movement and balance, reduce falls and symptoms of depression, and enhance quality of life among those with PD (Song et al. 2017). Taiji-

quan plus medication showed greater improvement in motor function than medication used alone (Yang et al. 2015).

PSYCHOLOGICAL OUTCOMES: Psychological outcomes have been examined in clinical populations that display symptoms of mental illness as well as in populations of healthy adults. Meditation has often been combined with other forms of treatment, most commonly cognitive behavioral therapy. Sedlmeier and colleagues, after reviewing hundreds of studies, report that meditation has a moderate to strong positive impact on stress management, intelligence, interpersonal relationships, self-concept, positive emotions, mindfulness, and attention (Eberth and Sedlmeier 2012; Sedlmeier et al. 2012). Moreover, weaker positive effects were found for reducing anxiety, depression and other negative emotions. Effects were stronger among long-term meditators and those with more extensive meditation training (Sedlmeier et al., in press). Effects varied across type of meditation.

Taijiquan and qigong have shown beneficial effects on quality of life for patients with breast cancer, schizophrenia, low back pain, heart failure and diabetes (Kelley and Kelley 2015). Taijiquan and qigong have also been shown to have beneficial effects on depression, anxiety, and stress management (Chi et al. 2013; Liu et al. 2015; Wang, Chan, et al. 2013; 2014; Wang, Lee, et al. 2014; Yin and Dishman 2014).

PULMONARY FUNCTION: Compared to no exercise and usual medical care, taijiquan has been shown to yield greater improvement in pulmonary function and exercise capacity among patients with chronic obstructive pulmonary disease (Guo et al. 2015; Ngai, Jones, and Tam 2016). Taijiquan has also been shown to enhance lung capacity, cardiorespiratory endurance, and cardio function in healthy adults (Zhang, Li, Huang, Liu, Tao, and Chen 2015).

SLEEP QUALITY: Insomnia and other aspects of poor sleep quality may occur alone or may accompany other conditions such as cancer and anxiety. Mindfulness meditation may provide mild improvement in sleep quality for patients with insomnia (Gong et al. 2016). Taijiquan and qigong improve multiple indicators of sleep quality (latency, duration, efficiency, disturbance) as well as quality of life, physical performance and symptoms of depression (Du et al. 2015; Wang, Lee, et al. 2016).

STRESS: Stress is widespread in modern society; it contributes to numerous conditions and reduces longevity. Meditation is a popular

method for managing stress. Pascoe, Thompson, Jenkins, and Ski (2017) report the impact of different types of meditation on multiple indicators of stress. They report that focused attention meditation reduces blood cortisol and systolic blood pressure, open awareness meditation reduces heart rate, and both forms of meditation reduce C-reactive protein, triglycerides, and tumor necrosis factor-alpha, which is a protein related to inflammation. Mindfulness meditation also appears to be successful in treating posttraumatic stress disorder (PTSD); interventions with greater mindfulness content were more effective (Hopwood and Schutte 2017). Overall, meditation decreases the markers of stress in a variety of different populations.

The Embodied Mind

Thousands of scientific studies of meditation, taijiquan and qigong demonstrate that these practices have a beneficial impact on many indicators of physical and mental health and enhance longevity. Research is also beginning to reveal how these practices achieve their effects. There appears to be growing agreement that they exert their influence through several psychological mechanisms (mind): attention regulation, body awareness, emotion regulation, and change in perspective of the self (Hölzel et al. 2011).

These mental processes are firmly embedded in the body and operate on and through biological mechanisms, in particular, those associated with stress buffering (Creswell 2017) and alterations in inflammatory response (Bower and Irwin 2016). These pathways are connected; mind and body interpenetrate each other. Meditation, taijiquan and qigong operate on both mind and body together. In particular these mindfulness practices operate synergistically to alter brain density, structure and integration across areas of the brain that increase with meditation experience and strengthen over time (Hölzel, Carmody, et al. 2011; Hölzel, Lazaar et al. 2011). Focused attention, open awareness and intentional awareness directed to fostering compassion and loving kindness engage different areas of the brain and stimulate different pathways to health and longevity (Ricard, Lutz, and Davidson 2014).

Although typically studied in isolation, the indicators of health and longevity we review above are related to each other. For example, stress

can trigger pain and inflammation, impairment in the immune system and reduced ability to thwart illness and disease. Conditions such as arthritis, cancer, fibromyalgia, multiple sclerosis, and Parkinson's disease may stimulate a stress response, which in turn can make these conditions worse. The mental state of mindfulness produced by meditation, taijiquan and qigong reduces the stress response and thus relieves multiple symptoms associated with these conditions. The following example illustrates this connectedness.

Falls are the leading cause of injury and death among older adults and cost an estimated \$31 billion per year in Medicare costs (Centers for Disease Control and Prevention 2016). The experience of falling may increase feelings of stress, anxiety and fear of falling, which may cause one to reduce physical activity and become weaker, and thus increase the chance of falling again or succumbing to serious illness. Loss of function and the experience of chronic health conditions, such as those we review above, increase the likelihood of depression and anxiety among older adults, particularly women, and increase the probability of suicide (Conwell, Van Orden, and Caine 2011).

Taijiquan improves musculoskeletal health through increased bone density and joint strength in the lower body, thus reducing the chance of falling, fear of falling, and the severity of injury associated with falls among older adults. Taijiquan combined with meditation can be effective for reducing anxiety and depression at the same time that it strengthens the body.

The ability of meditation, taijiquan and qigong to buffer the impact of stress and enhance resilience in the face of adversity may be the most important mechanism to explain the effectiveness of these mindfulness practices. Creswell and Lindsay (2014) explain how this may occur. The mental state of mindfulness, which is produced by meditation, taijiquan and qigong, increases the engagement of areas of the brain (e. g., pre-frontal cortex) that inhibit the stress response (a "top down" regulatory pathway), particularly with emotionally laden events.

At the same time, mindfulness also reduces reactivity of stress processing regions of the brain (e. g., amygdala, a "bottom up" regulatory pathway), that is, one is able to face stressors with greater equanimity. The experience of stress increases release of hormones (e. g., cortisol), which at excessive levels weaken the immune system (e. g., reducing

CD4+ lymphocyte counts) and thus increase risk of infection and susceptibility to illness as well as increase anxiety and depression. Stress may activate proteins (e. g., nuclear factor kappa-light-chain-enhancer of B cells) that control gene expression related to inflammation and cell survival (Muehsam et al. 2017). Over time, chronic stress increases morbidity and mortality. Meditation, taijiquan and qigong help to buffer these processes and reduce their damaging impact.

Bower and Irwin (2016) suggest that meditation, taijiquan and qigong alter the autonomic nervous system, which is a key regulator of inflammatory gene expression and the stress response. Bidirectional interactions between the brain (top-down) and peripheral systems (bottom-up) mediated by the autonomic nervous system are the mind-body link through which mindfulness practices exert their buffering effects (Taylor et al. 2010).

The autonomic nervous system (ANS) mediates the stress response and plays an important role in several physical and mental disorders. Thayer and Sternberg (2006) describe how the ANS regulates the cardiovascular system, glucose levels, reactions to stress, and inflammatory processes. The prefrontal cortex and amygdala, which are influenced by mindfulness practices, are important brain structures that regulate these systems via the vagus nerve. The vagus nerve extends from the brain down through the neck and chest and into the abdomen and colon; it connects to all the organs (except the adrenal glands). It helps to regulate heart rate and blood pressure, insulin secretion, stomach acidity, inflammation, and mental states such as anxiety and depression. Vagal regulation of inflammation and immune response may be one of the most important mechanisms underlying the effectiveness of meditation, taijiquan and qigong (Muehsam et al. 2017).

Vagal response increases the experience of positive emotions such as joy, hope, gratitude, awe, inspiration, and love and enhances psychological and social well being and explains how positive emotions strengthen resilience and psychological resources (Kok and Fredrickson 2010). Over time, experience of positive emotions strengthens vagal tone. Both open awareness (mindfulness) and intentional awareness (loving-kindness/ compassion) approaches to meditation increase the positive emotions that have been shown to strengthen vagal response (Fredrickson et al. 2017).

In sum, meditation, taijiquan and qigong change the brain and buffer the experience of stress. They exert a top-down (mind) and bottom-up (body) influence on physical and mental health and longevity. This influence is delivered through the autonomic nervous system, in particular, the vagus nerve. Strong vagal tone enhances positive emotions, health and longevity; weak vagal tone increases negative emotions, morbidity and mortality.

Conclusions

Health and longevity may be enhanced through changing the body to change the mind (bottom-up), or by changing the mind to change the body (top-down). This bidirectional influence is useful to teachers as practices may be directed to students based on their preference and preparation. Sitting meditation may be encouraged for those who can more easily sit still, whereas taijiquan and qigong may be suggested for those who are naturally more active. Some students will be receptive to all of these practices.

The large number of physical and mental symptoms that are influenced by taijiquan and qigong suggest that they may operate in a top-down as well as bottom-up fashion. Although speculation, the wide variety of physical movements combined with deep breathing and breath regulation, self-massage, relaxation, meditation and mindfulness, and qi cultivation based on principles of Traditional Chinese Medicine that are often included in taijiquan and qigong practice suggest that these practices may exert broader impact than meditation alone, particularly given the greater opportunity that these practice components may have to strengthen vagal response and enhance autonomic flexibility. This is an important area for future research.

Multiple gates exist to enter the Dao, and students should be encouraged to use the gate that opens most easily for them, whether it is sitting meditation, meditative movement with taijiquan or qigong, study of Daoist texts, dietetics, or all of the above (Davis and Kohn 2008). Most important is persistent practice guided by a teacher who embodies Daoist principles and can demonstrate them in daily life.

Daoists learned how to hack the body's central nervous system with the methods of self-cultivation they used to pursue health and longevity.

Those who diligently practice meditation, taijiquan and qigong will enhance health and longevity just as the Daoists of old.

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