The physical, physiological, and biological effects of qigong therapy

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Abstract

Qigong is a Chinese traditional practice that has been developed for thousands of years. One of its purposes is to improve and sustain health. Research has also shown that Qigong is effective in improving many health outcomes. Many research gaps exist, especially concerning study design and investigations into the physiological and biological effects of Qigong practice. To fill in the knowledge void, this review focuses on the state of qigong research regarding its physical, physiological, and biological effects. Our findings suggest that far-infrared, bio magnetic, and neurological applications are common measurements in understanding the physical effects of Qigong. Heart rate variations, pulse, and blood pressure changes are also commonly used in measuring physiological effects of Qigong. Last, biological effects of Qigong may include biochemical parameters, glucose, and immune parameters, among others. More methodological rigorous research exploring the particular physiological and biological pathway of Qigong practice and health outcomes is needed. Future research should also closely examine the feasibility and adaptability of Qigong therapy while evaluating the effects of Qigong versus other forms of mind-body exercise. Last, researchers, health providers and community leaders should investigate and improve the physical and psychosocial health and health behaviors of minority populations through culturally appropriate and adaptable exercises like Qigong.

Background

Qigong is an increasingly popular modality of traditional Chinese medicine (TCM) believed to be over 4,000 years old [1]. Written records referring to Qi (vital energy) and its effects are thought to be as old as 3,300 years. Qigong exercise is based on the traditional Chinese belief and Taoist philosophy that human body contains a network of energy pathways through which vital energy circulate. As a mind-body practice in Energy Medicine, Qigong aims to achieve a harmonious flow of vital energy in the body and regulate the functional activities of the body through regulated breathing, mindful meditation, and gentle movements [2].

Qigong is a mind–body practice that uses breathing adjustment, body postures and/or mindful meditation to harmonize the body, mind, and spirit. Its main theory is that discomfort, pain, and sickness are a result of energy; that is, if there is a free flow of energy (Qi) and a balance of energy (Qi) in the energy channel, health can be improved, maintained and disease prevented. Blocked Qi was considered to be the original of many illnesses and diseases [3].

In the past decade, a growing number of studies globally have critically evaluated the effectiveness of qigong exercise in physical, mental and cognitive health improvement. Existing systematic reviews and meta-analyses examined the clinical evidence of the beneficial effects of qigong on different medical conditions, including cancer [4-7], cardiopulmonary diseases [8,9], hypertension [10-12], infectious deceases [13]; movement disorder [14,15] and fibromyalgia [16]. Other reviews also examined the overall effectiveness of qigong on chronic condition management including diabetes [17] and pain management [18]. Several recently published systematic reviews further provided evidence on the effectiveness of Qigong exercises on reducing psychological distress including depressive symptoms, anxiety symptoms [19,20].

Whereas health effects of Qigong practice have been addressed in the current medical and public health literature, few reviews have systematically evaluated the key components of Qigong biofields that are closely associated with its healing effects, except two review articles published about ten years ago [21,22]. Researchers in complementary and alternative medicine (CAM) continue to have different conceptualization in ways to measure Qi. Chen et al proposed that if there was bioenergy, then it should be detectable and measurable by physical instruments or biomarkers [23]. Others argued that bioenergy also exists in the forms of electrical, magnetic, and/or electromagnetic substance in nature and that it’s transmission and reception would interact at the cellular and molecular levels [24]. However, to date, the concept of Qi bioenergy has not been well-articulated. This research gap points to the ongoing methodological challenges in Qigong therapy research; mainly, knowing what is to be measured, what could be measured, and finding appropriate technologies and measurements to properly develop the approaches and instrumentation associated with the practice of Qigong [25,26].

In light of the limitations of previous reviews, and the high demand

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for more understanding of Qigong therapy, the purpose of this review paper is to address critical measurement issues pertaining to Qigong research. The aims of this review are to understand 1) the physical and biological detector measurement of Qigong; 2) the physiological detectors of Qigong; 3) research gaps in and implications of the practice of Qigong and its impact on the health of the global populations.

Methods

The study design was developed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Studies eligible for inclusion were papers assessing the biological, physical, chemical, and physiological detectors of Qi in Qigong studies. The search keywords included the following: Qigong, Qi therapy, Qi practice, Chi-Kung bioenergy Qi detectors. Due to the scope of this research intended to focus on Qigong specifically, we did not include search terms in other forms of therapies such as Reiki or other energy-training methods. Two investigators independently reviewed the manuscripts identified by the search methods and selected qualified studies according to the content, criterion and construct validity.

The literature search was conducted online using both medical and social science databases, including MEDLINE, PubMed, PsychInfo, China journals full-text database (www.cnki.net), Wan Fang data and Google Scholar. The search was limited to studies available in full-text, and written either in English or in Chinese, and published between 1990 and 2015. Exclusion criteria included using life sensors as detectors, or involving human body or animals as detectors, laboratory tests on cultured plates or treat enzyme samples, conference proceedings, unpublished manuscripts, school term reports, or no data reported. Full search methodology for publications is shown in Figure 1.

Results

Our search yielded 59 English-language results and 13 Chinese-language results; the major methods for measuring or evaluating Qigong effects can be classified into the following three categories of detector: 1) physical signal detectors; 2) physiological dynamics methods; 3) biological materials as detectors.

Physical signal detectors

Physical detectors are the primary methods that most researchers have used as they fit into the traditional energy assessment model (Table 1) [22]. Such studies typically assess heat, magnetism, electricity, or radiation. Many other exploratory studies of external Qigong effects have used various physical detectors, including Gamma ray, microwave, and high-frequency X-ray. Body temperature changes before, during, and after the practice of Qigong have been documented by many empirical studies [27-29], in which far-infrared measurement was amongst the most commonly used physical detectors of Qi [21]. A few studies tested with far-infrared thermography demonstrated the significant temperature change on the body surface with infrared detectors during both self-qigong practices or with a qigong healer. Working with Spanish children aged between 10-12, Matos et al. [30] showed that there were statistically significant changes in temperature measured by thermography occurred during the exercises and at the beginning and at the endpoint of the observation interval (p<0.001), and effects remain stable after weeks of training. Through direct observation, Lo et al. [27] reported significant changes in the maximum temperature measured by infrared images in body surface temperature including front, back and face regions. However, current far and infra-red findings are predominantly limited in Chinese literature, and most focused on directly observing the external Qi dissipated from Qigong masters rather than recording the flow of Qi per se [21].

Biomagnetic is another commonly used application to measure healing effects. The application of magnetic field is a widely used ancient healing technique around the world. Previous studies in therapeutic touch suggested that the 8- to 10-Hz frequency band may be associated with emission from the human biofield during therapeutic interventions [31,32]. Similarly, in an observational Qigong study conducted in Japan, Hisamitsu [33] found that the 8-12 Hz frequency band was emitted when participants performed breathing techniques. This study finding suggested that Qigong breathing appeared to stimulate a large biomagnetic field emission similar to other alternative therapies.

Brain change associated with Qigong has been central in scholarly inquiries. Due to its high costs, few studies have thus far investigated functional-MRI changes in large-scale studies. Current available f-MRI studies with Qigong masters suggested that the response amplitude of the SII-insula region under the state of Qigong (3.5%) was greater than that before Qigong (1.2%) [34]. Another observation study in China reported significant frontal lobe and left temporal lobe changes (p<0.05) under Qigong stimulation state [35]. After a short-term meditation training, MRI images showed increased brain connectivity in the anterior cingulated, suggesting that Qigong meditation might have the potential to rewire neurons in the brain and rebuild connections among neurotransmitters. However, limited study to date has included f-MRI scans before and after Qi practice with a large sample of layman practitioners.

In addition to neuroimaging techniques such as f-MRI, EEG and
Table 1. Physical Detector Measurements of Qigong

| Author, Year         | Study Design | Population Characteristics | Methods | Outcome of Interests | Main Findings                                                                 |
|----------------------|--------------|----------------------------|---------|----------------------|-------------------------------------------------------------------------------|
| Far-Infrared Measurement |              |                            |         |                      |                                                                               |
| Matos et al., 2015 [30] | OS 7         | Europe 10-12 6F1M None WB  | A prospective study of participants with no experience as baseline data, and after QG practice as intervention data. | To examine the effects of QG exercises by thermography of the hands prior to and after a seven-week QG training program | Statistically significant changes in temperature measured by thermography occurred during the exercises and at the beginning and the endpoint of the observation interval (p<0.01). Heart rate results point to a significant decrease in the QG program, the mean heart rate at the beginning of the program was 102.9 beats per minute, with a standard deviation of 20.5 beats per minute and at the end these values were 92.0 and 17.2, respectively. |
| Lo et al., 2007 [27]  | OS 1         | U.S. NR NR NR NR NR  | A male patient with car accident was treated with external Qi (no touch) over 3 month period. | To document infrared images of change in body surface temperature. | Significant changes in the maximum temperature were reported in some parts of the body before and after healing. The largest differences were 6.7°F in the back region (97.87 to 91.17), 1.14°F in the lower back region (96.26 to 85.12), 0.97°F in the front region (97.33 to 96.36), 3.83°F in the upper back region (101.97 to 98.14), and 2.11°F in the face (101.11 to 99). |
| Shin et al., 2003 [73] | OS 11        | Korea 10-17 NA None NR  | Observational study of students who put hands in front of the sensors and emitted Qi from the palms to be measured by magnetometers. | To measure the bio-magnetic field emitting from palm during Qi emission. | Two out of eleven QG trainees emitted strong magnetic fields during the emitting time interval. We present the real-time data and also analyze characteristic features by the methods of variance, windowed Fourier transform, and wavelet transform. The characteristic frequencies are on a broad band between 0.1 Hz and 4 Hz. |
| Hisamitsu et al., 1996 [33] | OS NR       | Japan NR 1M1F Masters NR  | The biomagnetic field was measured with differential coils around 80,000 turns, a magnetic needle compass and a digital electromagnetic wave detection device. | To measure the biomagnetic field emanating from QG | When participant started to perform breathing, magnetic field of 200-300 mT at frequency of 8-12 Hz was emitted. When the rotation of the needle occurred, a reproducible magnetic field of 800-1500 mT (8-15 mGauss) was indicated on the digital measuring device tested 12 times. |
| fMRI                  |              |                            |         |                      |                                                                               |
| Yu et al., 2007 [34]  | OS 4         | China 60 ± 12; range 45-72 M Master > 30 yrs NR | EEG in each of masters was performed 1 day before fMRI and recorded continuously from 10-15 min after beginning QG practice. The heart and respiration rate of 4 masters were monitored during the test. | To assess change of brain function under QG state with brain stimulation by fMRI and other physical index monitoring including heart rate and respiration rate | No heart rate change was found between non QG state and the QG state, and the mean HR was 65/min. Before QG practicing, SI and SII-insula regions, Brodmann areas, the cingulate cortex, the thalamus, and the cerebellum were all activated (p<0.05) while 15 min after that, the activated areas were decreased , which were mainly at the SII-insula region and Brodmann areas (p<0.05). The response amplitude of the SII-insula region under the state of QG (3.5%) was greater than that before QG (1.2%). |
| Chan et al., 2006 [35] | OS 10        | Hong Kong M-299 M Masters NR | Participants were instructed to close their eyes and relax for the duration of the experiment. Each participated in two two-minute experimental sessions. The first session was stimulation of the Dan Tian. The second session was stimulation of the right hand which was applied to the medial right arm. | To study brain activations associated with external stimulation of the lower Elixir Field | The brain regions activated during Dan Tian stimulation were more extensive than those for right-hand stimulation. The time course analysis, comparing the blood oxygen level dependent percentage signal change in the Dan Tian stimulation with the rest condition showed significant differences in the right frontal lobe (p<0.05, paired t-test) and left temporal lobe (p<0.01, paired t-test). The signal changes for the thalamus (right: p<0.01, left: p<0.05) and insula (right: p<0.01, left: p<0.01) were also significant. |
| EEG                   |              |                            |         |                      |                                                                               |
| Authors, Year | OS | Country | Age (N=) | Gender (F:M) | Major | Master, Level | Group | Condition | Methodology | Findings |
|-------------|-----|---------|---------|-------------|-------|--------------|-------|-----------|-------------|----------|
| Faber et al., 2012 [37] | OS | Taiwan | M=41.5, SD=10.4, Range=20-56 | F:M | Masters | Feng San Lee's QG | All QG meditators practice 10 min of “thinking of nothing” and “qigong meditation”, the post mortem localization of brain electric activity during the two meditation conditions was compared using sLORETA functional EEG tomography. 19 EEG electrodes were applied. | To assess EEG changes during QG meditation | The strength of voxel activation was statistically significant (p<0.05) between the meditation conditions “Thinking of Nothing” and “Qigong” only in the frequency bands of alpha-2 (critical t(6.286 for corrected p<0.05); best observed p(corrected) = 0.0074 was at t = 7.966) and beta-1 (critical t(6.423 for corrected p<0.05); best observed p(corrected) = 0.026 was at t = 8.171). In the alpha-2 frequency band, all 125 voxels that differed significantly were more active in “Qigong” than in “Thinking of Nothing”; they formed a single cluster in the parietal Brodmann areas 5 (N = 25), 7 (N = 84), 31 (N = 14), and 40 (N = 2), in the right hemisphere. |
| Ho et al., 2011 [74] | OS | China | 18-24 | 30M34F | NR | Participants were assisted to enter QG state (relaxation, tranquility, naturalness) by given the sore feeling is able to induce participants to enter QG simulation state | To assess whether acupuncture-made sore feeling is able to induce participants to enter QG simulation state | When in QG state: From baseline to QG state: EEG reading: 16.8 ± 5.9% to 38.5 ± 13.5%; skin temperature from 33.1 ± 0.13c to 33.79 ± 0.24; electromyogram from 9.4 ± 4.3 to 11.6 ± 35.6; skin conductance level from 13.2 ± 4.9us to 30.2 ± 11.7us; finger pulse amplitude pulse/min from 32.5 ± 7.8 to 65. ± 14.3; heart rate pulse/min from 72.9 ± 8.6 to 70 ± 11.9 |
| Qin et al., 2009 [38] | OS | 1 China | 2 U.S. | Masters 25 yrs experience | NR | 5-10 minutes of eyes-closed rest EEG was recorded before and after a period of meditation for 30 minutes or longer; EEG was recorded from nineteen electrodes (Fp1, Fp2, F7, F3, FZ, F4, F8, C3, C2, C4, T3, T4, P3, PZ, P4, TS, T6, O1, and O2) with the Electro-Cap according to the 10-20 montage system referenced to linked earlobes. | To assess EEG changes after QG exercise | Once QG started, the dominant alpha-1 activities increased from 3.1 uv2 at premeditation baseline to 4.8 (55% increment); when subjects denoted experience of meditative state at approximately 20 minutes into the exercise, the alpha-1 reached 27.5 uv2 (787% increment). Average anterior frontal midline theta power at baseline was 1.8 and beta, 0.6. 30 minutes after meditation, both bands reached maximal power enhancement at 2.7 (50% increment) and 4.1 (583% increment). For interhemispheric coherence, F3-P4 increased from 0.7 to 0.8 during meditation. |
| Fong et al., 2004 [75] | OS | NA | NA | Half masters, half-no-experience | NR | Recording EEG data follow the ABAB (Qigoing1, relaxation1, Qigoing2, relaxation2) experimental stages. | To compare the 0, u, and β power between the masters and the novice groups | Simultaneously examine the brain asymmetry on α power to understand the regulation of QG on emotion. The EEG theta band had main effect on group(F(1, 29)=5.01, p<.05), stage(F(1, 29)=6.72, p<.05) and electrode (F(12, 29)=23.0, p<.05) between Qigong and control groups; 2. the EEG alpha band had main effect on group (F(12, 29)=2.09, p<.05) and electrode (F(1, 12)=50.14, p<.05) between both groups and group and electrode interaction (F(1,12)=3.44, p<.05). |
| Litscher et al., 2001 [29] | OS | Austria | M=58, F=47 | M1F | Master | NR | Participants were measured with changes in cerebral blood flow velocity, near-infrared spectroscopic parameters, EEG and stimulus-induced 40 Hz oscillations during QG | To assess the effects of QG exercise on brain function with biomedical neuromonitoring equipment | From direct observation, Heart rate increased from 72 to 76 bpm and diastolic blood pressure from 154/90 to 160/95 mmHg. After the application of multimodal stimuli and when the master concentrated on intense imagined stimuli, 22.2% increase in mean blood flow velocity (vm) in the posterior cerebral artery, and a simultaneous 23.1% decrease of vm in the middle cerebral artery. |
| Lee et al., 1997 [76] | OS | Korea | M=25 (20-32) | 7M6F | 1-3 years | EEG reading obtained with each participant seated with eyes open 10 minutes before QG. 1 hr QG: sound exercise (25min), motion (15min), meditation (20 min). 10 min post QG EEG reading was obtained again. | To examine effect of QG on EEG patterns and activation coefficients | In all but 2 participants, scores during post QG were significantly lower than those during pre-QG [F (1,12)=12.345, p<0.001]. In occipital regions, findings showed a significant increase in mean relative power of alpha wave during the sound exercise (p<0.05) and meditation (p>0.05) compared to baseline [F(4,48)=7.248, p=0.001] at left side, and [F(4,48)=5.537, p<0.001] at right side. |
EMG are also commonly used to measure the electrical activity of the brain surrounding Qigong [36]. Effects were shown across practitioners of various experiences, ranging from Qigong masters to those with no prior experiences. The effects appear to be most pronounced in the studies conducted among Qigong masters of at least 20-25 years of practice [37,38]. However, a recent review study in the physiological effects of biofield-based therapies suggested that EEG changes were inconsistent and may not specific to biofield therapies [39]. Evoked potentials, another electrophysiological recording method, have also been applied to Qigong research. Although signals can be recorded in the cerebral cortex, visual cortex [40], auditory evokes potential [41], or spinal cord, studies using evoked potentials are limited to measuring the effects of qigong meditation. There is limited pre, during or post data on the physical exercise component of Qigong.

**Physiological dynamics methods**

Table 2 presents physiological methods in assessing therapeutic effects of Qigong. Clinical research studies consistently use heart rate variability as a marker of autonomic tone. The majority of the studies included in this review presented HRV either as a primary or secondary outcome or interests. Although most researcher concluded significant changes in heart rate before, during, and after Qigong exercise, there are other observational studies that showed no heart rate changes before or after QG practice [34]. Regarding heart rate variability, a quasi-experimental design study among wheelchair-bound older adults observed no differences between experimental groups and control groups regarding all HRV parameters after 12 weeks of Qigong [42]. Another cross-sectional analysis reported, however, that all HRV parameters were significantly higher in practitioners than those of non-practitioners. The number of years of Tai Chi experience did not include in this review presented HRV either as a primary or secondary marker of autonomic tone. The majority of the studies

| Study | Design | Country | Sample Size | Gender | Condition | Measures | Findings |
|-------|--------|---------|-------------|--------|-----------|----------|----------|
| Kuo et al., 2003 [77] | OS | Taiwan | 18-24 | None | NQ | Physiological changes are assessed with EEG in the right frontal lobe of cerebrum, finger pylese amplitude (FPA), heart rate, skin conductance level (SCL), ECG, EMG (measured from the dorsum of right hand). | To assess physiological changes when entering the QG state (breathing) |
| With et al., 1997 [78] | Double-blind RCT | China | NR | NR | Half experience, half none | 3 groups- students of QG/students non-believers. | To measure the variable energizing effect of QG along with the anecdotally and experimentally established relaxation effect of TT therapy relative to patient belief and expectancy using sEMG |
| Zhang et al., 1993 [40] | QED | China | G1: 61.9 ± 8.5, G2:48.5 ± 15.1, G3: 54.3 ± 11.6, G4:49.0 ± 12.1 | NR | NR | Flash visual evoked potentials (F-VEPs) were recorded from the occipital scalp: Group 1,2,3,4 NQ practitioners for 0.5-5.5 yrs. 2) 12 NQ practitioners for 0.5-3 yrs; 3) 11 none-practitioners; 4) 11 QG (non-specified) practitioners | To investigate the functional state of the cerebral cortex during QG meditation |
| Liu et al., 1990 [41] | OS | China | 21-54 | 1-20 yrs experience | NR | Evoked potentials measured before, during, and after QG, through Short Latency Auditory Evoked Potentials (LAEP) | To investigate the effect of QG on short-latency auditory brainstem evoked response (ABER), middle-latency response (MLR, 10-50 ms), long-latency auditory evoked potentials (AIR, 50-200 ms) |

*OS: Observational Study; RCT: Randomized Clinical Trials; QED: Quasi experimental design; ED: Experimental design; EQ: External Qi Therapy; TT: Therapeutic touch; NR: None.
Table 2. Physiological/CVD Detector Measurements of Qigong

| Author, Year | Study Design | Population Characteristics | Methods | Outcome of Interests | Main Findings |
|--------------|--------------|-----------------------------|---------|----------------------|---------------|
| #  | Country | Age | Sex | Previous QG Practice | Type of QG |
| Chang et al., 2014 [79] | QED | 77 | Taiwan | QG: 63.0 ± 6.4; CON: 65.1 ± 7.4 | 17M66M | None | DD | QG participants participated 30 min of eight-form moving meditation 3 times per week for 12 weeks, control group continued their normal daily activities. To examine the effects of QG on the heart rate variability and peripheral vasomotor response of middle-aged and elderly people in the community. The t-test and the z² test were used to analyze group differences; the mean values of SDNN, total power, low frequency, and high frequency for the experimental group increased from 26.98, 618.86, 152.40, and 107.03 points to 32.39, 828.95, 232.08, and 157.07 points after the 12-week follow-up (p<0.05). |
| Zhang et al., 2006 [80] (In Chinese) | CT | 88 | China | 55+ | 44M, 44F | None | WQX and YJJ | Participants practice WQX and YJJ twice a day, 40 minutes for each practice, last for 6 months. BB, HR, HI, SV, SW, SWI, CO, CI, TPR, C, BW and BMI were tested at the beginning of the intervention, in the middle, and after intervention. To investigate the effect of QG on the function of Cardiac and Cerebral vessel among older adults. After 6 months of intervention, there appeared a trend of improvement of BP, HR, HLS, SV, SW, SWI, CO, C1, T, and C2 for men and women. There seems to be a gender difference for the outcome in this study that women, in general, improved more significantly than men. For female participants, SBP, DBP, SV, CO, C1, T, and C improved significantly while the significant improvements for male |
| Lee et al., 2005 [81] | OS | 40 | Korea | QG group: 24.1 ± 3.4; CON: 23.7 ± 3.1 | M | None | NR | Single blinded-20 randomized into QG, 20 in sham QG. Sham QG was administered by the same QG master, who aimed to mimic the gestures used in the actual QG with no effort or intention to emit real Qi. Participants had 10 min rest and their ECGs recorded for 10 min (Pre). Following QG (or sham QG) of 10 min, they had their second ECG measured for 10 min after 10 min rest (Post). To examine electrocardiography (ECG) parameters-heart rate variability including Heart Rate (HR), low frequency heart rate (LF), high frequency heart rate (HF), LF/HF ratio before and after QG. Paired t-tests show that from pre to post: HR (bpm) QG: 70.5 ± 7.1 to 66.9 ± 5.8; CON: 70.4 ± 4.3 to 69.3 ± 2.8 (p<0.05); LF (ms²/H) QG: 48.7 ± 13.6 to 34.4 ± 16.1; CON: 45.3 ± 14.5 to 42.0 ± 21.2 (p<0.05); HF (ms²/H) QG: 51.3 ± 13.6 to 65.6 ± 16.1; CON: 54.8 ± 14.6 to 58.2 ± 21.2 (p<0.05) LF/ HF QG: 1.10 ± 0.57 to 0.65 ± 0.53; CON:1.01 ± 0.68 to 0.99 ± 0.80 |
| Lim et al., 1993 [82] | OS | 10 | U.S. | 20.50 ± 1.84 | 10M10F | None | N | Participants participated in a 20-minute group instructional session for 10 consecutive days before testing of its treatment effects. The testing protocol followed a C1-T-C2 design, where C1, T, and C2 represented the first, treatment, and second control period, respectively. Each period consisted of a 5-minute interval, and thus each testing session consisted of 15 minutes. To examine effect of QG on cardio-respiratory changes. One-way analysis results indicated there was a significant decrease in respiratory exchange ratio between T and C2. (0.73 ± 0.06 to 0.79 ± 0.04, p<0.05). A significant increase in ventilator efficiency for carbon dioxide production (3.88 ± 0.76 to 3.13 ± 0.44) was found between C1 and T. |
| Sun et al., 1992 [83] (In Chinese) | OS | 26 | China | 57.8 ± 8.8 | 12M6F | Master | Various | Heart rate (HR) were recorded when practicing different QG breathing techniques; each participant chose 2 out of 4 techniques: A-Kidney-enhancement Gong (KG), B-Lung-enhancement Gong (LG), C-Heart-enhancement Gong (VG), D-Cancer-removing Gong. To test effects of 4 QG breathing pattern on variability of heart rate. Direct observations showed that the amplitude of peak in HR high-frequency area increased with a reduction of the low-frequency 2/ high-frequency (LF2/HF) ratio during the breathing pattern KG (0.56 Hz), LG(0.63 Hz), and HG (0.66), compared to normal breathing (2.66 Hz, p<0.05) indicating the vagal activity increased QG breathing pattern. |

Pulse

| Author, Year | Study Design | Population Characteristics | Methods | Outcome of Interests | Main Findings |
|--------------|--------------|-----------------------------|---------|----------------------|---------------|
| Dong X (2016) | The physical, physiological, and biological effects of qigong therapy | J Transl Sci, 2016 | doi: 10.15761/JTS.1000142 Volume 2(4): 206-228 | | |
| Study                                      | Country | Age Range | Gender | Practice Duration | Control Group | Treatment Group | Intervention Details                                                                 | Results                                                                                                                                                                                                 |
|-------------------------------------------|---------|------------|--------|-------------------|---------------|-----------------|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Lan et al., 2004 [84]                     | OS      | Taiwan     | 59.1 ± 6.6 | YM                | NR            | QG: practice for 2.3 (1.5) yrs, TCC: practice of 4.7 (2.3) yrs | Measure cardiorespiratory function during subsequent bicycle exercise test: 3 groups: QG (n=12), TCC (n=12), Sedentary (n=12) QG: 10 min warm-up, 30 min QG, 10 min concluding exercises, at least 3X/week led by instructor TCC: 20 min warm-up, 24 min TCC, 10 min cool down, at least 3X/week, let by instructor | To compare cardiorespiratory responses among QG practitioners, TCC practitioners, and sedentary controls during cycle ergometer TCC has highest beneficial effect but QG still enhances breathing efficiency. Between QG and sedentary at ventilator threshold. No significant difference in heart rate (116 ± 11 vs. 111 ± 20, p=NS). Higher O2 uptake (15.5 ± 3.1 vs. 12.3 ± 1.9, p<.05). Higher O2 pulse (91 ± 2.2 vs. 72 ± 1.3, p<.05). No significant difference in work rate (60 ± 20 vs. 55 ± 13, p=NS) |
| Jones et al., 2001 [45]                   | OS      | HK         | 27-55   | YM                | GL            | Numbers of peripheral blood cytokine-secreting cells were determined by ELISPOT in, before participants were taught the practice of Qigong and after 3, 7 and 14 weeks of daily practice | To test to impact of QG practice on Blood pressure, pulse rate, blood cortisol level and production of IFNγ, IL4, IL6, IL10, IL12 and TNFα Based on direct observation, Pulse rate decreased from 76.3 ± 11.4 (mean ± SD) before training to 69.8 ± 9.4 at 3 weeks (p<0.05). Plasma cortisol levels at baseline were 394 ± 115 nmol/l and at 3, 7 and 14 weeks were 328 ± 126 (p<0.05), 376 ± 109 (not significant) and 318 ± 110 (p<0.05) respectively. Numbers of blood cytokine IL4 and IL12-secreting cells remained stable. IL6 increased at 7 weeks and TNFalpha increased in unstimulated cultures at 3 and 7 weeks but decreased at these times in LPS and SAC-stimulated cultures. IFNγamma-secreting cells increased and IL10-secreting cells decreased in PHA-stimulated cultures, resulting in significant increases in the IFNγamma/IL10 ratio. Cortisol, a known inhibitor of type 1 cytokine production, was reduced by practicing QG |
| Blood Pressure                            |         |            |         |                  |               | | All decreased significantly. Heart rate (beats, min): Pre-training: 72 ± 6; After training: 71 ± 6, mid-67 ± 5; after meditation: 65 ± 6; post training: 67 ± 5 (p<0.01) Respiration rate: pre: 12.5 ± 2.7; sound: 11.5 ± 3.4, mid: 9.5 ± 2.6; medi: 8.1 ± 2.1; post: 9.8 ± 3.0 (p<0.001). Systolic blood pressure(mmHg): pre=120 ± 9; sound: 112 ± 7; mid: 110 ± 7; medi:109 ± 5; post 116 ± 7 (p<0.01) Diastolic blood pressure: pre: 86 ± 9; sound: 79 ± 8; mid: 74 ± 6; medi:71 ± 7; post 78 ± 5 (p<0.01) |
| Lee et al., 2000 [46]                      | OS      | Korea      | 28 ± 9  | YM                | CDSB          | 1.3 ± 0.2 yrs | Participants practice QG 1 hr/ daily (10 min sound exercise, 10 min motion, 40 min meditation), 6 times/week, directed by a master | To assess blood pressure, heart and respiratory rates during QG exercise All decreased significantly. Heart rate (beats, min): Pre-training: 72 ± 6; After training: 71 ± 6, mid-67 ± 5; after meditation: 65 ± 6; post training: 67 ± 5 (p<0.01) Respiration rate: pre: 12.5 ± 2.7; sound: 11.5 ± 3.4, mid: 9.5 ± 2.6; medi: 8.1 ± 2.1; post: 9.8 ± 3.0 (p<0.001). Systolic blood pressure(mmHg): pre=120 ± 9; sound: 112 ± 7; mid: 110 ± 7; medi:109 ± 5; post 116 ± 7 (p<0.01) Diastolic blood pressure: pre: 86 ± 9; sound: 79 ± 8; mid: 74 ± 6; medi:71 ± 7; post 78 ± 5 (p<0.01) |
| Zeng et al., 2013 [85] (In Chinese)        | RCT     | China      | 120.60  | YM                | FSG           | None           | Participants were divided into two age groups: 60-69,70-79. BP were tested 5-10 minutes after performing Relaxation, meanwhile, HR data were collected. Participants were diagnosed with ISH 5-26 years | Effects of FSG on hypertension Compare with control group, there’s a statistically significant reduction of SBP, DBP and DP among intervention group. (p<0.05) for age range 60-69, SBP is 132.37 ± 6.36 vs. 140.87 ± 6.99 DBP is 81.62 ± 9.42 vs. 88.63 ± 11.45 DP is 51.03 ± 13.06 vs. 59.96 ± 12.36 for age range 70-79, SBP is 136.88 ± 6.39 vs. 142.88 ± 14.53 DBP is 81.65 ± 1.03 vs. 86.4 ± 12.08 DP is 55.28 ± 2.24 vs. 59.96 ± 9.84 HR reduced but not statistically significant.(P>0.05) |
| Lin and Huang, 2013 [86] (In Chinese)     | RCT     | China      | 127     | YM                | WQX           | None           | Intervention N=68 Use medicine to control hypertension, meanwhile, practice WQX at least 6 times a week, 30 minutes for each practice. Last for 6 months, BP were tested at the beginning of the intervention and after the intervention. Control group uses medicine to control hypertension. | To test effects of WQX on the intervention of hypertension senior adults Compare with control group, there’s a statistically significant improvement of SBP among intervention group. SBP: 130.68 ± 14.35 vs. 132.4 ± 18.00 P<0.05 The change of DBP was not statistically significant DBP: 78.09 ± 10.23 vs. 76.03 ± 10.31
Lee et al., 2004 [89]  
RCT  36  Korea  QG: 52.6 (5.1)  C: 54.3 (5.5)  None  SX PXG  RCT 8 wk. QG: 52.6 (5.1). C: 54.3 (5.5).  Test the effects of QG on BP

Cheung et al., 2005 [88]  
RCT  8  HK  QG: 57.2 (9.5)  C: 51.2 (7.4)  NR  G.L.  QG: 60 wk. (120 min x 4 weeks with a QG instructor or physiotherapist, then monthly and encouraged to practice 60 min in AM and 15 min in PM x 7 days). CON: Exercise of stretching, walking, and pressure-relieving activities similar to QG

To test the effects of QG versus exercise on BP

Sun et al., 2008 [90] (In Chinese)  
Three Arm RCT  60  China  Range: 60-69  QG group: 65.7 (2.3)  Running: 65.3 (2.4)  C: 64.8 (2.3)  Male only  None  SX PXG  RCT 8 wk. (30 min x 2 days/wk).  Test the effects of QG on BP

Blood Lipids

Li et al., 2013 [50] (In Chinese)  
CT  48  China  Participants practice QG 1 hour each day, last for 8 weeks; TC, TG, HDL-C and LDL-C were tested at the beginning and after the intervention.

To test the effects of QG on blood lipid metabolism of elder intellectuals
To explore the effect of QG exercise on blood lipid metabolism and life quality of senior adults. After 3 months of intervention, there appeared a trend of improvement of blood lipid metabolism and life quality for both men and women in middle and senior age groups. There seem to be an age difference for the outcome in this study that seniors, in general, improved more significantly than middle age participants. For middle age female participants, none of the results improved significantly, for senior female participants, TC, HDL-C and LDL-C improved significantly; for middle age male participants, only HDL-C improved significantly; for senior male participants, TG, HDL-C and LDL-C improved significantly.

Middle age female:
- TC (mg/dl): 214.1 ± 40.7 vs. 216.8 ± 45.8
- TG (mg/dl): 157.4 ± 27.7 vs. 163.5 ± 32.8
- HDL-C (mg/dl): 36.4 ± 3.4 vs. 27.3 ± 3.8
- LDL-C (mg/dl): 126.9 ± 43.7 vs. 140.5 ± 44.3

Senior female:
- TC (mg/dl): 242.2 ± 42.8 vs. 261.7 ± 33.8
- TG (mg/dl): 177.2 ± 31.2 vs. 193.5 ± 34.8
- HDL-C (mg/dl): 36.2 ± 9.8 vs. 32.3 ± 11.8
- LDL-C (mg/dl): 146.9 ± 40.2 vs. 173.5 ± 31.2

Middle age male:
- TC (mg/dl): 226.9 ± 41.4 vs. 242.8 ± 43.2
- TG (mg/dl): 161.4 ± 30.5 vs. 178.5 ± 35.2
- HDL-C (mg/dl): 33.2 ± 7.8 vs. 24.9 ± 6.7
- LDL-C (mg/dl): 131.2 ± 50.1 vs. 160.3 ± 30.6

Senior male:
- TC (mg/dl): 221.1 ± 40.8 vs. 243.7 ± 43.6
- TG (mg/dl): 164.1 ± 29.4 vs. 182.6 ± 33.1
- HDL-C (mg/dl): 29.6 ± 7.8 vs. 23.4 ± 9.7
- LDL-C (mg/dl): 134.6 ± 27.1 vs. 160.3 ± 30.6

SF: 77.8 ± 14.1 vs. 68.9 ± 17.2 p=0.002

Lee et al., 2004
RCT 36 Korea OG: 52.6 ± 5.1; Control: 54.3 ± 5.5
OG: 8M9F; Control 6M13F None SXPXG Hypertensive patients were randomly divided into either the OG group (N=23), or a wait-listed control group (N=24). During 8-week study, OG group practices QG for 30 min. Prior to the intervention (before) and eight weeks after (after), 5 ml of blood was collected at 8 a.m. to measure lipid metabolism. After 10 min of rest, the patient’s blood pressure was measured by the auscultator method. To assess the effectiveness of Qigong on blood pressure and several blood lipids: high-density lipoprotein (HDL) cholesterol, Apolipoprotein A1 (APO-A1), total cholesterol (TC), and triglycerides (TG) There were significant changes in systolic blood pressure (SBP) and diastolic blood pressure (DBP) in the OG group after eight weeks compared with before (OG SBP 152 to 238, p<.001; OG DBP 98 to 84; p<.001). There was also significant change in the DBP of the control group (p<.01). There were significant differences between the OG and control groups in HDL (p<.01) and APO-A1 (p<.01). After eight weeks of intervention, TC (p<.05), HDL (p<.001), and APO-A1 (p<.05) changed significantly compared with before in the OG group.

1BP=Blood Pressure, HR=Heart Rate, ISH=isolated systolic hypertension
2SBP=systolic blood pressure DBP=diastolic blood pressure DP=Double Product
3TC=total cholesterol, TG= triglyceride LDL-C=low-density lipoprotein cholesterol, HDL-C=high-density lipoprotein cholesterol
The majority of the empirical studies aiming to quantify Qi started with measuring changes in blood pressure and pulse. A growing number of direct observational studies have consistently shown the decrease of blood pressure and pulse after practicing Qigong [45-47]. Researchers utilized a mix of vital measures including heart rate, respiration rate, systolic blood pressure, diastolic blood pressure to demonstrate the health and clinical effects of Qigong in community-dwelling persons as well as patients with diabetes [1], hypertension [47], or cancer [48]. The recent randomized control trials (RCT) on Qigong exercises show that intervention groups (Qigong) reported a significant reduction of Systolic blood pressure, but not diastolic BP [49]. In addition, most RCT design is only up to 6 months post intervention. Further studies need to be clear about design mechanism as well as length in potential follow-up time.

Other physiological studies which measure blood lipids change in Qigong exercise generally found an improvement of blood lipids metabolism after Qigong. Interestingly, Li et al. [50] observed a gender difference in the change; compared to male participants enrolled in the trial, female participants (n=24) reported greater and more significant improvement. Similarly, another quasi-trial designed study reported the improvement in blood lipids metabolism was more significant in the older adults groups compared to a younger age group [51]. While both studies show that Qigong practice can improve blood lipids metabolism under well-designed conditions, studies with blood lipids metabolism as the primary outcome of interests were limited to only projects conducted in China. Its generalizability to other racial/ethnic groups remains to be tested.

**Biological materials as detectors**

Given the biological material, such as individual cells and biological molecules such as proteins and antibodies are assumed to possess Qi (vital energy), and that they may be particularly sensitive to the internal qi or external qi emitted by qigong practitioners; the concept of a biological detector has long been documented in the field of CAM. Table 3 presents biological detectors commonly used in Qigong research.

Measuring indicators of metabolic syndrome including BMI, HDL cholesterol, triglycerides) and glucose control have been linked with understanding the medical effects of Qigong [52]. A recent randomized control trial in diabetic patients in the U.S found that compared to control group, participants in Qigong intervention group reported significant reduction in plasma glucose levels (p<0.01), and significantly improved fasting glucose (p<0.01) [53].Using glucose detectors will contribute in understanding the unique presence of Qigong efforts and dynamics.

Biomarkers are generally considered to be proteins or enzymes – measured in serum, plasma, or blood – that provide independent diagnostic and prognostic value by reflecting an underlying disease state. Recent studies in examining the medical effects of Qigong practice have begun to incorporate biomarker assessments mainly in immune parameters including IL6, TNF-α, or ACTH. A direct observational study in Hong Kong reported an increase of IL6 at seven weeks of Qigong practice and that TNF-α increased in un-stimulated cultures at three and seven weeks [45]. In a double-blinded RCT of Qigong vs sham-Qigong study in Korea, Lee et al. [47] reported that there were significant effects of group and time, and group x time interaction for ACTH levels (p<0.05). Another RCT study of Qigong conducted in Spain reported that the levels of TNF significantly changed after intervention: Cytokines TNF-α (pg/ml) for the control group was 1.89 and IFN-γ (pg/ml) was 10.40 [54]. However, with the exceptions of studies on Qigong meditations, other biomarker studies assessing endorphin or stress hormones remain scarce [55].

Growth hormone is known to undergo large changes in circulating concentrations in response to stimuli such as exercise, sleep and fasting. Growth hormone stimulates the liver and other organs, including the skeleton, to synthesize and secrete insulin-like growth factors (IGF) [56]. In addition, the modulation of immune cells by Qigong therapy may be related to the activity of the sympathetic nervous system (SNS) as well as the neurohormonal axis. Using an observational study design with 10 Korean older adults, Lee et al. [57] argued that mild movement of Qigong changed somatic growth and enhanced neurohormone concentration and immune functions. Corroborate with this finding, Ryu et al. [58] reported strong correlations between growth hormones and insulin-like growth factor after Qigong practice. These results showed how Qigong training impacted the secretion of growth factors in practitioners, while additional research is now required to determine which aspects of Qigong training contributed to these changes in growth factors, and to ascertain whether exercise in general would result in similar alterations, or if they were augmented by the traditional meditative aspects of Qigong. Observational studies and clinical trials have thus far concluded that Qigong therapy may induce psychological, neurohormonal and immunological changes [59-61].

**Discussion**

In summary, our review shows that there has been an increased body of literature on Qigong-related effects concerning physiological processes and variables. Most of these studies suggested that Qigong practice brings significant changes on parameters such as the blood pressure, heart rate variability, decrease of plasma triglycerides, total cholesterol and low-density lipoprotein (LDL) cholesterol, an increase of HDL cholesterol, skin temperature, as well as immunological and neurohormonal enhancements.

These findings show that the bio-physiological effects of Qigong may apply to persons of all age groups, ranging from primary school children, college students to mid-age adults or older adults. Our finding also demonstrates that most of the studies on Qigong-related effects concerning physiological, biological, or CVD-related processes were applied in various chronic disease prevention or intervention studies. We still have the most rudimentary understanding on how these processes may manifest itself in chronic stress reduction or stress management. Overall, many authors only examined stress as secondary outcomes [62]. Trial research has found that Qigong practice may improve certain conditions, especially those that are chronic like musculoskeletal disorders and psychological distress. Type of Qigong and length of practice may influence results. However, many limitations exist, especially concerning study design. More methodological rigorous research exploring the particular pathway of Qigong practice and stress reduction is needed.

Another important methodological issue to consider in understanding physiological effects of qigong pertains to the standardized issues of Qigong practice. From the available data, it appears that there are differences in the bio and physiological outcomes depending on the type of Qigong practiced, making it difficult to draw a concrete conclusion. However, our review was unable to find sufficient evidence that one form of Qigong is more effective than another for any specific condition. Even in studies where results are not significant, it is unclear if it might be a study design limitation or...
### Table 3. Biological Detector Measurements of Qigong

| Author, Year | Study Design | Population Characteristics | Methods | Outcome of Interests | Main Findings |
|--------------|--------------|----------------------------|---------|----------------------|---------------|
| **Biochemical Parameters** | | | | | |
| Miao et al., 2009 [93] (In Chinese) | RCT | 50 | China | QG group: 63.32 ± 6.55; Control Group: 63.68 ± 6.8 | | |
| | | | | | | |
| | 25M, 25F | None | BDJ | BPTG, TC, HDL-C, LDL-C | Explore the effect of BDJ on blood lipid of senior adults with hyperlipidemia. | |
| | | | | | Compare with control group, there’s a statistically significant improvement of TC, TG, LDL-C, HDL-C among intervention group. (p<0.05) | |
| | | | | | TC: 5.26 ± 0.51 vs. 5.96 ± 0.66 | |
| | | | | | TG: 1.15 ± 0.16 vs. 1.46 ± 0.22 | |
| | | | | | HDL-C: 1.85 ± 0.26 vs. 1.46 ± 0.22 | |
| | | | | | LDL-C: 3.32 ± 0.29 vs. 3.7 ± 0.49 | |
| | | | | | (TC=total cholesterol, TG=triglyceride, LDL-C=low-density lipoprotein cholesterol, HDL-C=high-density lipoprotein cholesterol) | |
| Liang et al., 2014 [94] (In Chinese) | RCT | 60 | China | QG: 54.8 ± 7.6; C: 55.7 ± 8.8 | Explore the effect of BDJ on blood lipid of senior adults with hypertension. | |
| | | | | | Compare with control group, there’s a statistically significant improvement of SBP/DBP, TC, TG, LDL-C, HDL-C among intervention group. (p<0.05) | |
| | | | | | SBP: 136.4 ± 10.4 vs. 145.7 ± 12.3 | |
| | | | | | DBP: 85.1 ± 7.5 vs. 89.5 ± 7.3 | |
| | | | | | TC: 4.08 ± 0.8 vs. 5.13 ± 0.84 | |
| | | | | | TG: 2.12 ± 0.54 vs. 2.72 ± 0.66 | |
| | | | | | HDL-C: 1.34 ± 0.35 vs. 0.98 ± 0.38 | |
| | | | | | LDL-C: 2.45 ± 0.78 vs. 3.04 ± 0.77 | |
| Liu et al., 2010 [95] (In Chinese) | RCT | 62 | China | QG: 65.7 ± 3.1, 62-69 | | |
| | | | | | | |
| | All F | None | YJJ | TG, TC, HDL-C, LDL-C, SOD, GSH-Px and MDA were tested at the beginning N=32 Participants practice QG 6 times a week, each time 40-50 minutes with the teaching of QG masters. Last for 6 months. The intervention and after the intervention | | |
| | | | | | Explore the effect of YJJ on blood lipid and free radical metabolism of female senior adults. | |
| | | | | | Compare with control group, there’s a statistically significant improvement of LDL-C, HDL-C, SOD, GSH-Px and MDA among intervention group. (p<0.05) | |
| | | | | | HDL-C: 1.79 ± 0.67 vs. 1.37 ± 0.73 | |
| | | | | | LDL-C: 2.41 ± 0.53 vs. 2.57 ± 0.65 | |
| | | | | | SOD: 113.92 ± 14.38 vs. 103.37 ± 1.27 | |
| | | | | | GSH-Px: 167.14 ± 19.93 vs. 131.97 ± 20.38 | |
| | | | | | MDA: 3.98 ± 0.64 vs. 4.62 ± 0.89 | |

### Glucose

| Author, Year | Study Design | Population Characteristics | Methods | Outcome of Interests | Main Findings |
|--------------|--------------|----------------------------|---------|----------------------|---------------|
| Liu et al., 2010 [1] | OS | 11 | Australia | 42-65 | None | KMQG | A single group pre- and post- trial; Participants with elevated blood glucose attended Tai Chi QG exercise training for 1 h to 3 h, 3 times per week for 12 weeks; and were encouraged to practice the exercises at home. Outcomes assessed immediately prior to and after 12 week program. | | |
| | | | | | To evaluate the feasibility, acceptability and effects of a Tai Chi and Qigong exercise program in adults with elevated blood glucose. | | |
| | | | | | Significant improvements between baseline and post-intervention in indicators of metabolic syndrome: bodyweight (baseline: 76.38; post: 73.42; mean difference -2.96kg, p<0.001) BMI (base: 27.83, post: 26.78; mean difference −1.05, p<0.001), waist circumference (base: 93.16; post: 90.36; mean −2.80 cm, p<0.05), and systolic (baseline: 129.73; post: 118.09; −11.64 mm Hg, p<0.01) and diastolic blood pressure (baseline: 84.55; post: 74.82; mean−9.73 mm Hg, p<0.001). Indicator of glycaemic control: HbA1c (baseline 5.59; post 5.27; mean −0.32%, p<0.01), insulin resistance (baseline: 2.61, post 2.08; mean −0.53%, p<0.05), | | |
Bilirubin

**Sun et al., 2010** [53]

- **RCT**
- **32** U.S.
- **M56.3, SDR.1**
- **NR** None NA
- **Group 1 (n = 11)** received the Qigong intervention, group 2 (n = 10) served as the control group, and group 3 (n = 11) received the progressive resistance training (PRT) intervention as an active comparator. Participants in all three groups were asked to maintain their conventional diabetes care, including medications, diet, and exercise, during the study. Participants attended weekly Qigong or PRT group sessions (60 min per week) conducted by certified instructors in addition to practicing twice a week at home for 30 min per session.

**To investigate the effects of Qigong relative to physical exercise or standard care on glucose control in adults with type 2 diabetes.** Statistically significant reductions in plasma glucose levels were observed in the Qigong group (184.9 ± 35.3 vs. 161.9 ± 40.5 mg/dL, P<0.003 by paired t-test). Both the PRT group and the control group increased plasma glucose levels over time (143.8 ± 35.0 vs. 154.0 ± 44.7 and 156.4 ± 36.6 vs. 168.4 ± 49.1 mg/dL, respectively; not significant [NS]). Fasting glucose of the QG group significantly improved compared with that of the PRT group and the control group (P<0.003 and P<0.001, respectively, by one-way ANOVA). A1C remained unchanged in the control group during the intervention (7.9 ± 0.8 vs. 7.9 ± 1.6%) but declined slightly in both the PRT group (8.6 ± 1.2 vs. 7.9 ± 1.6, NS) and the QG group (8.8 ± 1.1 vs. 8.1 ± 1.3, NS). Fasting plasma insulin levels increased slightly in both the PRT group (24.3 ± 28.8 vs. 30.2 ± 39.9, NS) and the control group (12.6 ± 4.6 vs. 20.1 ± 10, P=0.08) but remained unchanged during the intervention in the Qigong group (13.3 ± 6.2 vs. 13.4 ± 5.7, NS).

**Youngwansincoetha et al., 2013** [96]

- **RCT**
- **64** Thailand
- **M35SDD 5.6**
- **NA** None TCQ
- **Participants were randomly assigned to an intervention group (n=32) and control group (n=32). Participants in the intervention group practiced a 50-min tai chi qigong exercise program, three times a week for 12 weeks during the period of 3–6 months postpartum. Control group received usual care.**

**To investigate the effect of tai chi qigong exercise on plasma glucose levels and health status of postpartum women with type 2 diabetes.** A statistically significant reduction in fasting plasma glucose, glycosylated hemoglobin and blood pressure were seen in the intervention group when compared with the control group (P<0.05) at 12 weeks. Mean fasting plasma glucose in the intervention and control groups at 12 weeks were 120.19 (SD=17.51) mg/dl and 129.88 (SD=15.23) mg/dl, respectively. There were no significant between-group differences in body-weight or body-mass index at trial completion.

**Lee et al., 2004** [47]

- **RCT**
- **32** Korea
- **Experiment:** 30.5 ± 5.9; control: 31.2 ± 7.3 CDSB
- **Double blinded; 32 participants were randomized to a QG training group (25 min exercise; 15 min movement; 20min meditation) and a sham QG control group who performed the same movements without gathering or moving Qi. Blood sampling was completed within 30 s and subjects rested for 10 min before the experiment began.**

**To assess plasma concentrations of ACTH, cortisol, and Aldosterone of QG practice**

Paired t-tests show after Qi-training, the plasma concentrations of ACTH, cortisol, and aldosterone decreased, but these levels did not change in the control group; For the ACTH level, there were significant effects of group [F(1, 30) =6.3,p<0.05] and time [F(1, 30) =4.6, p<0.05] and group x time interaction [F(1, 30) =7.9, p<0.01]. For the cortisol level, there were significant effects of time [F(1, 30) =4.7, p<0.05] and group X time interaction [F(1, 30) =10.5, p<0.005], but no significant effect of group. For the aldosterone level (Figure 1C), there were significant effects of time [F(1, 30) =6.7, p<0.05] and group X time interaction [F(1, 30) =10.9, p<0.005], but no significant effect of group.

**Iwas et al., 1999** [97]

- **RCT**
- **10** Japan
- **54.72, 61 median**
- **NR** NR NR
- **30-40 minute duration, 30 minutes after lunch CON: Convention walking Plasma glucose levels Pulse rates**

Plasma glucose levels decreased during both exercises (from 228 mg/dl before to 205 mg/dl after conventional walking) and (from 223 mg/dl before to 216 mg/dl after qigong walking). In both situations the results after exercise decreased more than those in the group with no exercise (229 mg/dL: P<0.025). The pulse rates increased after conventional walking (from 77 to 95 beats per minute; P<0.025) and were higher than those in the group with no exercise (70 beats per minute; P<0.01) and those after qigong walking (79 beats per minute; P<0.05).
| Source | Study Design | Country | Age | Gender | Group | Recruitment | Randomization | Intervention | Follow-up | Outcome Measures |
|--------|--------------|---------|-----|--------|-------|-------------|---------------|--------------|-----------|-----------------|
| Yang and Tao, 2015 | RCT | China | 108 | M=69.8 (7.8), range 51-90 | 54M, 54F | None | BDJ | 5.7 times per week, 35-40 minutes each time, last for 8 months | To investigate the effect of BDJ on bilirubin level of type 2 diabetes patients | After 6 months of intervention, TBIL, DBIL and IBIL improved significantly. TBIL: 13.6 ± 5.4 vs. 20.1 ± 7.2, p<0.01 DBIL: 3.5 ± 1.8 vs. 4.1 ± 2.1, p<0.01 IBIL: 10.1 ± 3.9 vs. 15.8 ± 5.3, p<0.01 |
| Oh et al., 2010 | RCT | Australia | 162 | QG M=60.1 (11.7); CON M=59.9 (11.3) | QG M31, F48; CON M38, F45 | NR | Modified from traditional QG | Patients with a range of cancer were recruited. QG: medical QG plus usual care, N=54, duration 10 weeks, 2 supervised 90 min session each week. CON: usual medical care, N=83 | Measured at baseline and at 10 weeks post-intervention | To evaluate the use of Medical Qigong compared with usual care to improve inflammation (Serum CRP) of cancer patients. |
| Oh et al., 2008 | RCT | Australia | 30 | Age 35-75, M=54 (9) | 8M22F | NR | Modified from traditional QG | Patients with a range of cancer were recruited. QG: medical QG plus usual care, N=15, duration 8 weeks, 2 supervised 90 min session each week. CON: usual medical care, N=54 | To evaluate the use of Medical Qigong compared with usual care to improve inflammation (Serum CRP) of cancer patients. |

### Inflammatory Markers

| Source | Study Design | Country | Age | Gender | Group | Recruitment | Randomization | Intervention | Follow-up | Outcome Measures |
|--------|--------------|---------|-----|--------|-------|-------------|---------------|--------------|-----------|-----------------|
| Oh et al., 2010 | RCT | Australia | 162 | QG M=60.1 (11.7); CON M=59.9 (11.3) | QG M31, F48; CON M38, F45 | NR | Modified from traditional QG | Patients with a range of cancer were recruited. QG: medical QG plus usual care, N=54, duration 10 weeks, 2 supervised 90 min session each week. CON: usual medical care, N=83 | Measured at baseline and at 10 weeks post-intervention | To evaluate the use of Medical Qigong compared with usual care to improve inflammation (Serum CRP) of cancer patients. |

### Salivary Biomarkers

| Source | Study Design | Country | Age | Gender | Group | Recruitment | Randomization | Intervention | Follow-up | Outcome Measures |
|--------|--------------|---------|-----|--------|-------|-------------|---------------|--------------|-----------|-----------------|
| Chan et al., 2013 | RCT | Singapore | 34 | NR | NR | NR | NR | QG was practiced twice a week by the study group (n = 18) while a control group (n = 16) had no intervention. | To measure stress reduction by salivary biomarkers | Increases in secretion rates of salivary immunoglobulin-A, and decreases in salivary cortisol concentrations were seen only in the Qigong group |
| Sousa et al., 2012 | Prospective Controlled Intervention | Portugal | 16 | QG M=11.5, SD=0.7; CON: M=12, SD=0.0 | None | WQ | None | QG was practiced over seven weeks, twice a week, for 30 min with a waiting list design and instructions to perform the same exercises at home daily. Control group: wait-list design | To understand performance-related anxiety and physiological stress functions | Heat rate: QG group decreased (107.0 ± 21.8 to 96.0 ± 18.9, M=11 ± 7) and increased in CON group (81.0 ± 9.5 to 86.0 ± 7.2; M=5 ± 9), p<0.01 Salivary cortisol levels: Both QG (5.46 ± 1.51 to 2.82 ± 1.58 M=0.265 ± 0.165) and CON (4.56 ± 5.00 to 3.21 ± 3.91; M=0.132 ± 0.306) decreased; difference not significant (p=0.282) |
| Chow et al., 2012 | OS | Hong Kong | 68 | M=44.2, SD=11.0 | 23M, 45F | None | CMG | The changes in outcomes over four repeated measures: pretest (week 1), midweek (week 4), posttest (week 8), and follow-up (week 12). Salivary cortisol was assayed using ELISA kit. Data collection was done in the morning. The subjects were required to rest for 15-20 min before blood pressure and heart rate were taken. Then, they were given standardized questionnaires to complete. After that, salivary samples were collected. | To measure stress reduction by salivary biomarkers and blood pressure | T-test results show QG group had significantly lower systolic (F[1,63]=4.08, p=0.048) and diastolic blood pressure (F[1,63]=4.37, p=0.041) than the wait list control group after 8 weeks of qigong intervention. In week 12, with increased significant levels and effect sizes, the qigong group experienced lower systolic blood pressure (F[1,63]=6.59, p<0.01), diastolic blood pressure (F[1,63]=4.49, p<0.038), and lower cortisol levels (F[1,62]=15.91, p<0.001) |

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| Study                          | Country | Sample Size | Intervention Duration | Gender Distribution | Treatment | Controls | Outcome Measures | Findings |
|-------------------------------|---------|-------------|-----------------------|---------------------|-----------|----------|------------------|----------|
| Bayat-Movahed et al., 2008    | Iran    | 23          | 22-24                 | 10M13F              | YQG       | None     | NK cells         | Increased NK cell activity in the experimental group compared to control. |
| Vera, 2015                    | China   | 100         | 6 months              | 60F                 | None      | CDSB     | NK cell activity | Increased NK cell activity in the experimental group compared to control. |
| Yu et al., 2008               | Korea   | 100         | 6 months              | NR                  | None      | WQX      | NK cell activity | Increased NK cell activity in the experimental group compared to control. |
| Lee et al., 2003              | Korea   | 60          | 2 months              | 35M                  | None      | CDSB     | Immune cell numbers | Increased immune cell numbers in the experimental group compared to control. |

**Immune Parameters**

**NK Cells**

Differences were found between the experimental and control groups, with the experimental group showing higher NK cells numbers compared to the control group. The percentage of NK cells was significantly higher in the experimental group versus the control group (p<0.05) after 1 month. The NK cell activity was statistically significant (p<0.05). The unstimulated saliva volume after Qigong exercises was significantly higher compared to the pre Qigong phase. The saliva pH was 7.116d ± 0.137 for the measurements. The level of salivary S-IgA was 105.45 ± 69.41 mg/mL for the first measurement and 156.23 ± 88.56 mg/mL for the second measurement, which showed a statistically significant difference between the two measurements of salivary S-IgA (P=0.005).
| Lee et al., 2005 [107] | RCT | 18 | Korea | Experimental: 26.8 ± 1.2; control: 26.1 ± 1.7 | M | None | CDSD | 9 experimental subjects did 1 h of QG under a master; consisted of 10 min resting, 15 recting; 15 slow movement; 20 meditation, and 9 control participants relaxed during the same time; not required to do anything. Blood was drawn 10 min before QG, within 10 min of the end of QG, and 2 h after QG. Human peripheral blood was obtained by venipuncture using heparinized syringes | To access acute effect of QG on natural killer cell (NK) and cytotoxic activity | For cells incubated for 4 h, there was a significant main effect of time [F(2,32) = 3.4, p < .046] and time × group interaction [F(2,32) = 6.5, p < .005], but no significant group effect. For cells incubated for 16 h, only the time × group interaction was significant [F(2,32) = 4.5, p < .019]. NKCA increased significantly after Qi-training. Immediately after training, cytotoxic activity was 80% above control values in the cells incubated for 4 h, and 60% above control values in cells incubated for 16 h. NK cell cytotoxicity and NK cell number were not significantly correlated (r = .272, p < .17) in the QG group |
|---|---|---|---|---|---|---|---|---|
| Jung et al., 2006 [108] | OS | 24 | Korea | QTNM: 25 ± 5; QTT-M: 26 ± 3 | M | None | CSEH | Participants were randomized into QTN-received external Qi without touching (N=12) or QTT-received Qi with touching (N=12). Hormone assays including serum levels of cortisol and melatonin are collected. Immunological function including neutrophils and NK cell are measured. Participants are measured pre (10 min before), post I (10 min after) and post II (1 hour after) qi therapy. | To examine whether there are differences between QG healing touching and non-touching in hormone assays and immunological function | Nonparametric statistical tests revealed no significant differences between the effects of QTN and QTT (all p > .05). Separate Wilcoxon signed rank tests showed that: Cortisol (μg/dl): QTN Pre 7.4(6.1-8.5), post I 5.8 (5.7-7.2), post II 4.4 (4.1-5.6); p>0.001; vs. QTT 7.2 (5.9-7.8), post I 7.1 (6.0-7.5), post II 5.0 (4.6-5.7), p=.039. Superoxide generation (107 cpm): QTN: pre 3.7 (2.4-4.1), post I 4.3 (3.4-5.4), post II 3.5 (2.9-4.3), p<.001. QTT: pre 3.5 (2.7-3.6), post I 3.4 (2.9-4.0), post II 3.2 (2.7-3.9), p=.005. NK Cell (%) QTN pre 44.2 (40.5-51.1), post I 46.9 (45.0-61.3), p=.001 QTT pre 44.8 (37.3, 58.1), post I 55.9 (46.5-70.5), post II 49.4 (40.5-62.5), p<.01 |

- Growth Hormone

| Lee et al., 2005 [57] | OS | 10 | Korea | M=66 SD=3 | NR | None | CDSD | 1-hour QG practice; comprised resting for 10 min, followed by three kinds of exercise: sound recitation for 15 min, slow motions for 15 min, and meditation for 20 min. Peripheral blood was drawn from the median cubital vein before QG (Pre) and after the QG (Post) | To examine effects of QG on immune function and neurohormone concentrations | Significant increase in growth hormone (GH) after 1 h QG compared with the Pe samples (Pre: 0.38 ± 0.9 ng/ml; Post: 0.66 ± 0.8; p<.01). After 1 h QG, O2− generation was significantly higher than the Pre level (Pre: 4.57 ± 0.48 ng/ml; Post: 5.97 ± 0.49; p<.05), but no change in the number of neutrophils was observed in the peripheral blood. A significant increase in the O2− production of production by neutrophils (PMN) incubated with the serum collected after Qi-training was observed (p<.05) compared with pre-training serum. |
| Lee et al., 1999 [109] | OS | 26 | Korea | Older age group: M=59.86 ± 9.2, Younger age M=26.58 ± 1.03 | 14M, 12F | >0.6 year of experience | CDSD | 10 ml blood was drawn at pre (10-min before training), mid (before meditating), post-training | To observe the response of plasma growth hormone (GH), insulin-like growth factor-I (IGF-I) and testosterone (T) to an acute period of ChunDoSanBup (CDSB) Qi-training. | Although the basal level of GH was not different between the two groups, after the portion of the training in which the subjects were physically active (the mid-training point), plasma GH levels increased by 7.26 fold (p<0.05) in the elderly trainees and by 1.66 fold (p<0.05) in the young. In response to CDSB Qi-training, IGF-I levels in the young increased significantly at mid-training point, but there were no increase in the elderly. Significant correlations existed between GH and IGF-I levels in the young subjects, but not in the elderly. The T level at the mid-training point increased significantly in elderly subjects but not in the younger age. |
To examine the effect of QG on the plasma level of growth hormone (GH), insulin-like growth factor (IGF)-I and insulin like growth factor

- Cytokines

Mantzaneque et al. 2009, [54]

RCT 39 Spain 18-21 5M34F None BDJ Experimental participants were submitted to a QG training program consisting of three group 30-min session a week of one month. Control participants were not required to do anything in particular

To examine the effect of Qigong practice on serum cytokines, mood and subjective sleep quality

The practice of QG for one month did not alter serum cytokines. Cytokines TNF-α (pg/ml) for control group was 1.89 and IFN-γ (pg/ml) was 10.40. For intervention group CTNF-αwas 1.90, IFN-γ was 10.10; p value was 0.99 and 0.81 respectively.

- Others

Ryu et al., 1995 [110]

OS 65 Korea 20-50 M Various CDSB Group1 had QG training for 1-4 month (N=12), G2 5-12 months (N=21), G3 13-24 months (N=17), G4 >25 months (N=12). There is also control group (N=13)

To examine the effect of Qigong training on proportions of T lymphocyte subsets was investigated in human peripheral blood

Two-tailedored students t-test and ANOVA tests were used. Participants in G1 (2.19 ± 0.29), G2(2.41 ± 0.16), G3(2.38 ± 0.21) and G4 (2.59 ± 0.26) had higher ratio of CD4+/CD8+ T lymphocytes than control group (1.64 ± 0.14). The ratio of CD4+/ CD8+ T lymphocytes was increased 50% in a trainee group who practiced Qigong training more than 5 months compared to a normal healthy group who did not practice. The absolute number of CD4+ T lymphocytes was also elevated in trainee group with 100 cells/mm3 more than in normal healthy group.

Ryu et al., 1995 [112]

OS 28 Korea 20-45 NR None CDSB 12 in control group and 16 in QG group

To observe the difference between cell mediated immunity (CMI) through skin testing between QG and non QG group

Skin testing shows the number of responded antigens and the size of induration in the positive skin test was different in QG group to control group; maximum response of QG group peaked at 24 hr vs. 48 hr for control group. Using student’s t-tests, among antigens, maximum response against Trichophyton mentagrophyte (QQ:90.4 in 24hr. 75.0 in 48 hr, 57.1 in 72 hr vs. CON 18.2 in 24hr; 16.7 in 48 hr, 12.5 in 72 hr) and candida albicans (QQ:72.7 in 24hr. 75.0 in 48 hr, 100.0 in 72 hr vs. CON 18.2 in 24hr, 33.3 in 48 hr, 37.5 in 72 hr) were higher in QG in than control. QG group had larger duration size than control (p=0.05)

Blood Cells and Antioxidant Capacity

Yeh et al., 2006 [48]

QED/ CCT 67 Taiwan <39:12, 40- 49:27, >50: 28 F None CCQG All breast cancer patients about to undergo first chemotherapy 32 in experiment receive 21-day QG therapy 35 in control did not. White blood cells, platelet, and hemoglobin were measured on the day before chemotherapy and on days 8, 15, and 22 during chemotherapy

To examine the effects of QG on complete blood counts in breast cancer patients treated with chemotherapy

T-Test results show there were significant differences over the 3-week therapy in white blood cells between experiment group and control group in white blood cells (QG Baseline:5820 microliters, W1:3580, W2:1955, W3:3536, CON Baseline: 6166, W1: 3661, W2:3595, W4:6236, F= 115.76, P<0.001). platelets (QG Baseline: 246,228 microliters, W1: 194,523, W2: 217,222, W3: 312,000, CON Baseline: 263,687, W1: 189,950, W2:217,600, W3:356,000, F=25.29, P<0.001), and hemoglobin (QG-Baseline: 12.36, W1: 11.44, W2:11.32, W4:12.09; CON-Baseline: 12.75, W1:11.89, W2:11.42, W3:12.34. F = 15.59, P<0.001)

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**Wu et al., 2011 [113]**
CCT 55 China M: 55.61, F: 50-60 33M, 22F. NR WQX
Obese older adults practiced QG for 2 hr everyday for a year. Measures taken once every three months. MDA, TC, TG, LDL-c and HDL-c levels, SOD, CAT, GSH-Px activities were measured To examine the effect of QG on antioxidant enzymes activities, lipid peroxidation level, intestine probiotics in obese old people MDA: 3month 6.87 ± 0.34; 6M 6.01 ± 0.24*, 9M: 5.21 ± 0.19**, 12M 4.48 ± 0.22**;
TC (mmol/l): 3M 3.52 ± 0.04, 6M 3.15 ± 0.07*; 9M 2.82 ± 0.06**, 12M 2.61 ± 0.05**;
TG 3M 0.72 ± 0.02, 6M 0.64 ± 0.02**, 9M 0.55 ± 0.01**, 12M 0.43 ± 0.02**;
LDL-c 3M 0.57 ± 0.02, 6M 0.51 ± 0.03*, 9M 0.46 ± 0.01**, 12M 0.38 ± 0.01**;
HDL-c 3M 1.23 ± 0.06, 6M 1.54 ± 0.04**, 9M 1.78 ± 0.08**, 12M 2.04 ± 0.05**;
Bacillus acidophilus: 3M 5.25 ± 0.12, 6M 5.92 ± 0.06, 9M 6.93 ± 0.08**, 12M 7.48 ± 0.07**;
Lactobacillus casei: 3M 4.02 ± 0.09, 6M 5.06 ± 0.08**, 9M 5.72 ± 0.06**, 12M 5.99 ± 0.07**;
Bacillus bifidus: 3M 8.12 ± 0.09, 9M 8.91 ± 0.08*, 9M 10.79 ± 0.37**, 12M 11.61 ± 0.14** p value: compared with 3 month as control.
*: p<0.01, **: p<0.001

**Hormones and Thyroid Hormones**

**Kim et al., 2013 [114]**
OS 20 Korea NR F NR NR An experimental group and a control group were randomly organized with 10 women respectively, and QG training was provided three times a week during a 12-week period of time Body composition and aging-related hormone Decrease of their body fat mass and body fat percentage, and the increase of their growth hormone and estrogen.

**Ryu et al., 2006, [55]**
OS 20 Korea M=28 NR Yes CDSB Various forms of stress influence the balance of HPA axis in men. Blood was drawn at pre (-10min), mid (40 min), post (70min) of training. Plasma was collected. To examine the plasma level of beta-endorphin, ACTH cortisol, and DHEA-S response to Qi training Plasma cortisol and DHEA-S during mid training were not different from the pre-training (p<0.05). The plasma level of beta-endorphin during mid-time of qi training (25.08 pg/ml) has increased compared to pre-training (11.21 pg/ml)(p<0.05)

**Moon et al., 2004 [115]**
OS 25 Korea 26-29 M NR CDSB 16 men participated in a study of neuroendocrine effects of Qi-training, and nine healthy young men participated in a study of the immunological effects. Nine men volunteered to draw the blood sample for in vitro experiment of growth hormone on neutrophil responses. Blood was drawn before Qitraining [Pre, that is 10 min before Qi-training] and immediately after the Qi-training [Post, within 10 min (+10 min)]. To examine the effect of Qi-training on the plasma levels of GH and IGF-I, and investigate the immunological effects of Qi training by neutrophils, and investigate the immunological effects of Qi training by neutrophils, superoxide generation, and adhesion capacity

The plasma GH level was increased after Qi-training compared to pre Qi-training (p<0.05)
The plasma level of IGF-1 was significantly increased after Qi-training (p<0.05)
Significant priming of human neutrophils by GH was observed at 10 ng/ml (p<0.05), 100 ng/ml (p<0.01), and 250 ng/ml (p<0.05). According to the dose-response curve, we selected one submaximal dose as 250 ng/ml (p<0.05)

**M. S. Lee et al. [51]**
OS 15 Korea M= 60.93 (2.37), age range 49-81 10M, 5F, Mean 1.98 (0.21), 1-3 years of training CDSB Blood drawn 10 min before, training, before medication, and post-training 1 hour of qı-training (10-min rest, 15 min sound recitation, 15 min slow motions, 20 min mediation) Investigate how systemic treatment of CDSB on hormones on elderly subjects

1) T3 concentrates increased (1.84 ± 0.07 to 1.93 ± 0.07 and 1.99 ± 0.07 mmol/l, p<0.05) at pre-, mid-, and post-training. At post-training T3 concentrations increased (9.24 ± 5.68 to 99.8 ± 5.7 nmol/l, p<0.05) between pre- and mid-training
2) No significant differences in TSH (1.10 ± 0.20 to 1.16 ± 0.21 to 1.24 ± 0.22 µU/ml), Calcitonin (7.41 ± 0.55 to 7.80 ± 0.61 to 8.24 ± 0.87 pg/ml), Calcium (8.99 ± 0.27 to 9.16 ± 0.21 to 8.54 ± 0.18), and phosphorus (7.88 ± 0.03 to 7.86 ± 0.02 to 7.89 ± 0.02) at pre-, mid-, and post-training

**Metabolism and Immune Functions**
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| Reference | Design | Country | Age | Gender | Group | Protocol Details | Parameters Measured | Results |
|-----------|--------|---------|-----|--------|-------|-----------------|---------------------|---------|
| Lee et al., 2003 [116] | CDSB | OS | Korea | M=26 ± 4 | 9M | Age 26 ± 4 | To examine the effect of Qi-training on the immune system, especially neutrophil bactericidal function | The Qi-training enhanced superoxide (O2-) production, reaction velocity and neutrophil adhesion capacity and there were significant differences at Post I compared to before Qi-training (Pre). In addition, the number of white blood cells (WBC), monocytes and lymphocytes were changed significantly through Qi-training. Significant effects of Qi-training on reaction velocity [F(2, 16) = 4.95, p = 0.02] and neutrophil adhesive capacity [F(2, 16) = 3.92, p = 0.04]. There were significant increases in the number of WBC [F(2, 16) = 11.27, p = 0.001], monocytes [F(2, 16) = 1.43, p = 0.001] and lymphocytes [F(2, 16) = 4.6, p = 0.025] after Qi-training. |
| Manzaneque et al. 2004 [60] | RCT | 29 | Spain | 18-21 | 14M 15F | None | BDJ | 16 were allocated to the experimental group and the rest to the control group. The experimental subjects underwent a qigong training program, conducted by a qualified instructor, consisting of half an hour of daily practice for one month. The day before the experiment commenced and the day after it finished, blood samples were drawn from all subjects for the quantification of immunological parameters. To analyze the effects of a qigong program on various immunological parameters; including the number of leukocytes, the percentages of leukocytes, as well as the concentrations of immunoglobulins and complement | A between-group analysis of covariance (ANCOVA) was performed. After one month of practicing QG, significant immunological changes in Leucocytes (x10^3 cells/ml)[QG:5.66, CON:6.73, p=0.05], Monocytes (x10^3 cells/ml)[QG:0.45, CON:0.60, p=0.05], Eosinophils (x10^3 cells/ml)[QG:0.19, CON:0.29, p=0.05], Monocytes (x10^3 cells/ml)[QG:7.84, CON:9.05, p=0.05], with a consistently lower and broadly significant profile of these measures within the qigong practitioner group. |
| Huang et al., 2005 [117] (In Chinese) | CTS | 44 | China | 45-65 | 21M, 23F | None | BDJ | Participants practice BDJ 7 times per week, each time last for 50 minutes, Last for 10 weeks. During the intervention periods, participants keep a normal lifestyle. To investigate effect BDJ on the related indexes of free radical metabolism, including nitric oxide, malondialdehyde and superoxide dismutase | After 10 weeks of intervention, there shows a trend of improving in each groups of participants. There’s a significant reduce in malondialdehyde level for elderly female group. 3.59 ± 0.45 vs. 4.15 ± 0.68 p=0.05 There’s a significant improvement in nitric oxide level and superoxide dismutase level for elderly male; NO: 558.374 ± 243.91 vs. 471.13 ± 168.12 p=0.05 superoxide dismutase: 1.75 ± 0.17 vs. 1.49 ± 0.22 p=0.01 |
| Yang et al., 2007 [61] | RCT | 50 | U.S. | M=77.2 SD=1.3 | NR | None | NR | Intervention group (TQ) of participants = 27; wait-list control (CON) N = 23. Baseline pre-vaccine blood samples were collected. All subjects then received the 2003–2004 influenza vaccine during the first week of the intervention. Post-vaccine blood samples were collected 3, 6 and 20 weeks post-intervention for analysis of anti-influenza hemagglutination inhibition (HI) titers. To test whether 5 months of moderate Taichi and Qigong practice could improve the immune response to influenza vaccine in older adults | Significant increase in the magnitude and duration of the antibody response to influenza vaccine in TQ participants when compared to CON (p = 0.05). The vaccination resulted in a 173, 130, and 109% increase in HI titer at 3, 6, and 20 weeks post-vaccine, respectively, in the TQ group compared to 58, 54, and 10% in CON. There was a significant between-group difference at 3 and 20 weeks post-vaccine and at 20 weeks the TQ group had significantly higher titers compared to the pre-vaccine time point, whereas the CON group did not. |
due to the ineffectiveness of the type of Qigong therapy. Apart from the various styles and types of Qigong, our review also shows that the effect of Qigong can be either measured specifically at the meditation state, or during the component of physical exercise. Although from this current review we can see that both components have shown biological or physiological effects, limited research to date has juxtaposed measuring the physiological effects, limited research to date has juxtaposed measuring both components within the same study design. A recent randomized controlled trial reported that Baduanjin exercise, a popular form of Qigong, effectively reversed left ventricular remodeling in patients with post-Myocardial Infarction [63]. Future studies should examine the effectiveness of one form of Qigong to another, and further research is needed to more rigorously examine the better form of Qigong for specific quantifiable bio-physical effects.

While some subset of biofield devices, including those based on EEG heart rate variabilities that are widely used and employed in clinical settings, other devise modalities still have unclear clinical relevance. The interactions of biofield, defined as "an organizing principle for the dynamic information flow that regulates biological function and homeostasis", can affect and be affected by various biological, biochemical, cellular, and neurological across multiple levels of biology. As this review shows, given TCM posits that the disruption of energy flow is the cause of diseases, the harmonization of the flow of vital energy, or Qi, is posed as the solution to such ailments; in other words such interactions mainly focuses on the mechanical interactions. While current technological advances help us better assess the efficacy of devices, further research on Qi energy could benefit from the application of novel modalities with particular emphasis in mechanical or physical interactions [64].

Last, whereas many studies in this review have consistently suggested the significant physiological and biological effects of Qigong therapies, the broader question remains: what is the mechanical pathway behind such healing effects? Currently, biomedical researchers have stated that energy field therapies are effective because they project ‘information’ into tissues [65]. While researchers consider this an

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**Table 1**

| Study | Design | Participants | Methods | Results |
|-------|--------|--------------|---------|---------|
| Lu et al., 2006 [118] | QED 90 Taiwan | TCC: 53.0 (41-71); WTK: 58.5(48.0-70.0); Control: 56.4 (32-72) | Participants were divided into non-exercising control (N=30), TaiChiChung (TCC) practitioners (N=30) and WaiTanKung (WTK) practitioners (N=30). TCC: 40 min in duration (10 min warm up, 20 min exercise, 10 min cool down), WTK: 40 min in duration (5 min warm up, 30 exercise, 5 min relaxing). The resting standard 12-lead ECG, arterial blood pressure measurement were performed on each subject before TCC or WTK with the subject lying in supine position was performed on each subject before TCC or WTK in standing position. Measurements took place 30 and 60 minutes after exercise | To compare the effects of TCC and WTK on autonomic nervous system modulation and on hemodynamics |
| Lu et al., 2003 [119] | QED 40 Taiwan | WTK: 58.1 ± 5.9, CON: 55.9 ± 8.3 | Participants were divided into non-exercising control (WTK: 20 in WTK, 20 in control group) | To evaluate the effect of WTK on autonomic nervous system modulation in the elderly |

1TC=total cholesterol, TG=triglyceride LDL-C=low-density lipoprotein cholesterol, HDL-C=high-density lipoprotein cholesterol
2TC=total cholesterol, TG=triglyceride LDL-C=low-density lipoprotein cholesterol, HDL-C=high-density lipoprotein cholesterol, SOD=Superoxide dismutase, GSH-Px=glutathione peroxidase, MDA=plasma malondialdehyde; YJJ: Yi-Jing-Jing
3TBIL=total bilirubin, DBIL=direct bilirubin, IBI=indirect bilirubin

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**Table 2**

| Study | Design | Participants | Methods | Results |
|-------|--------|--------------|---------|---------|
| WTK 20 in WTK, 20 in control group | WTK: 5.6 ± 6.0 yrs, CON: 0 | Participants were divided into non-exercising control (WTK: 20 in WTK, 20 in control group) | To compare the effects of TCC and WTK on autonomic nervous system modulation and on hemodynamics |

Kruskal-Wallis one-way analysis of variance on ranks was utilized. Comparing 30 and 60 min after WTK and TCC: The mean RRI (RR intervals) (TCC 30 min: 0; 60 min; 60 min; 60 min; p=0.05), SDRR (Standard deviation of RR) (WTK: 40%; 60 min; 60%); TCC 30min:9%; 60 min:13%; p=0.05), and HFP (high frequency power) significantly increased (WTK 30 min: 21; 60 min: 47; TCC 30min: 27; 60 min: 35%; p=0.05), whereas the heart rate (WTK 30 min: 0.2; 60 min: 5.4; TCC 30min: 2.7; 60 min: 5.7; p=0.05), and VLF (normalized very low frequency power) decreased (WTK 30 min: -18.5; 60 min: -21.6; TCC 30min: 2.8; 60 min: -21.2). There were no significant differences (p>0.05) in the percentage changes in HRV measures and hemodynamics between WTK and TCC practitioners 30 and 60 min after exercise, indicating that the effects of WTK and TCC were similar in magnitude.

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**Table 3**

| Study | Design | Participants | Methods | Results |
|-------|--------|--------------|---------|---------|
| TCC: 2.0yr experience; WTK: 2.3 yr experience; Control: 0 yr | | | To compare the effects of TCC and WTK on autonomic nervous system modulation and on hemodynamics |

Kruskal-Wallis one-way analysis of variance on ranks was utilized. Comparing 30 and 60 min after WTK and TCC: The mean RRI (RR intervals) (TCC 30 min: 0; 60 min; 60 min; 60 min; p=0.05), SDRR (Standard deviation of RR) (WTK: 40%; 60 min; 60%); TCC 30min:9%; 60 min:13%; p=0.05), and HFP (high frequency power) significantly increased (WTK 30 min: 21; 60 min: 47; TCC 30min: 27; 60 min: 35%; p=0.05), whereas the heart rate (WTK 30 min: 0.2; 60 min: 5.4; TCC 30min: 2.7; 60 min: 5.7; p=0.05), and VLF (normalized very low frequency power) decreased (WTK 30 min: -18.5; 60 min: -21.6; TCC 30min: 2.8; 60 min: -21.2). There were no significant differences (p>0.05) in the percentage changes in HRV measures and hemodynamics between WTK and TCC practitioners 30 and 60 min after exercise, indicating that the effects of WTK and TCC were similar in magnitude.
interesting hypothesis, it leaves many unanswered questions of why tissue repairs are not activated naturally. Why would it be necessary to trigger healing process with an external signal and not something that occurs from within? And what is the mechanism behind the signal triggering healing process? Although the answers posed here are beyond what this paper aimed to address, next steps of scientific inquiry is necessary to better understand the bio-physical and chemical pathways of Qigong healing process.

Limitations

Despite these significant findings, there are some limitations to the current state of methodological issues pertaining to Qigong research. First, small sample size makes it difficult to interpret results and raises questions in generalizability. For example, current publication on external Qi on physical and biological systems frequently involves a single, or few qigong masters. Such situations may also introduce conflict of interests; participants should not be involved in the design of the study and should be blinded during the measurement. Second, there is a lack of sophisticated research design and compatible control groups undermine the results of many methods studies. Third, most Qigong practices may lack a facilitation program or manual to be successfully replicated. Given there is no generic form of Qigong, which calls to question how closely the type of Qigong used in these research trials resembles traditional forms, whether the cultural component of Qigong influences researchers and participants, and whether Qigong is treated just as a low-intensity exercise.

Furthermore, due to the lack of investigation in current literature, the role of culture or belief in Qigong practice remains central. In areas of biomedicine, cultural belief has been shown to impact compliance which could also influence health outcomes [66]. When investigating a practice or treatment such as Qigong which often explicitly incorporates non-biomedical beliefs about "energy," considering the influence of beliefs is necessary to examine which components may influence the outcome. Further, evidence shows that the concept of Qi, which does not have a biomedical analog, could very important among Qigong practitioners [67]. While their findings are impressive, most of these studies have methodological weaknesses. Moreover, it is not clear how much Chinese culture contributes to these outcomes or whether the benefits of qigong can be realized in an American population [68]. It is necessary to thoroughly examine how culturally relevant practices like Qigong may specifically relate to their health. Future studies should consider improving the conceptual framework on cultural beliefs in biomedical studies, and measures to better operationalize the potential impact of cultural beliefs in health outcomes.

Future research directions

In order to further understand the Qi measurement issues; there are multiple areas of research which should be addressed concerning study design, the complexities of Qigong, and the role of culture. It should be noted that CAM researchers have proposed a variety of directions for research pertaining to older adults which apply to Qigong research as well, including: understanding motivations for use or practice, safety concerns, longitudinal study design, larger sample size, including qualitative or ethnographic study design, and challenging the common health research approach of a biomedical framework [69]. Longitudinal, population-based studies should be conducted in community-dwelling settings to understand the current practice of and sociodemographic and health associations with Qigong. Although traditional double-blind clinical trials may be difficult to apply to qigong study due to a lack of a compatible sham qigong, in reality, a reasonably large sample size with a compatible control may be crucial for examining such an alternative therapy. The next step should also include information about culturally relevant exercise behaviors with additional qualitative interviews to understand their practice of Qigong.

Furthermore, future studies in this area should not only focus on physical or chemical detectors, but also use more biological or life detectors to increase our understanding of the bio-information contained within qigong. Furthermore, future research needs to evaluate the effectiveness of different forms of Qigong and another mind-body exercise, particularly Tai Chi, a similar and less meditative exercise to Qigong, in order to ascertain the appropriateness of these exercises for persons with different functional abilities.

Practice and policy implications

Last, this review has implications for health providers and policymakers. As one of the five treatment principles in traditional Chinese medicine, Qigong exercise postulates balance and harmonization as the principle aim of a treatment [70]. Recent CAM research of older adults has called for further integration of non-biomedical biomedical options for addressing certain health concerns [69]. Health providers should provide information to older adults about Qigong as exercise, especially since there is some evidence that Qigong practice lowers medical costs and visits [71]. Integrating Qigong classes into community exercise offerings may be able to address these issues of maintaining exercise in advancing age, especially for minority adults who desire culturally-specific group exercise activities [72].

Conclusion

In conclusion, the existing body of measurement research regarding Qi indicates that Qigong may be an effective way of improving health outcomes, including overall quality of life, psychological distress, and pain. Research methodology should rigorously evaluate Qigong versus other forms of mind-body exercise and whether cultural specificity and CAM beliefs affect health outcomes. Research scientists, health providers, and community leaders should work in concert to investigate and improve the physical and psychosocial health and health behaviors of minority populations through culturally appropriate and adaptable exercise like Qigong.
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