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...
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; and 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, PsycInfo, 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 using 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 infrared 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

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design</th>
<th>Population Characteristics</th>
<th>Methods</th>
<th>Outcome of Interests</th>
<th>Main Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>shin et al., 2003</td>
<td>OS 11 Korea</td>
<td>10-17</td>
<td>NA</td>
<td>None NR</td>
<td>The biomagnetic field was measured with differential coils wound 80,000 turns, a magnetic needle compass and a digital electromagnetic wave detection device. To measure the bio-magnetic field emanating 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.</td>
</tr>
<tr>
<td>Hisamitsu et al., 1996</td>
<td>OS NR Japan</td>
<td>NR</td>
<td>NR</td>
<td>1M1F Masters NR</td>
<td></td>
</tr>
<tr>
<td>Yu et al., 2007</td>
<td>OS 4 China</td>
<td>60 ± 12; range 45-72</td>
<td>M</td>
<td>Master &gt; 30 yrs NR</td>
<td>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%).</td>
</tr>
<tr>
<td>Chan et al., 2006</td>
<td>OS 10 Hong Kong</td>
<td>M-29</td>
<td>M</td>
<td>Masters NR</td>
<td>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 was 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 &lt; 0.05, paired t-test) and left temporal lobe (p = 0.01, paired t-test). The signal changes for the thalamus (right: p &lt; 0.01, left: p &lt; 0.05) and insula (right: p &lt; 0.01, left: p &lt; 0.01) were also significant.</td>
</tr>
<tr>
<td>Matos et al., 2015</td>
<td>OS 7 Europe</td>
<td>10-12</td>
<td>6F1M</td>
<td>None WB</td>
<td>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 occurred during the exercises and at the beginning and the endpoint of the observation interval (p&lt;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.</td>
</tr>
<tr>
<td>Luo et al., 2007</td>
<td>OS 1 U.S.</td>
<td>NR</td>
<td>NR</td>
<td>NR NR NR</td>
<td>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 95.12), 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).</td>
</tr>
</tbody>
</table>

EEG
### Faber et al., 2012 [37]
<table>
<thead>
<tr>
<th>OS</th>
<th>Country</th>
<th>Age</th>
<th>Gender</th>
<th>Group</th>
<th>Manual</th>
<th>Frequency Band</th>
<th>Effect of Meditation</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Taiwan</td>
<td>M=41.5, SD=10.4</td>
<td>3M5F</td>
<td>Masters</td>
<td>Master Feng-San Lee’s QG</td>
<td>All QG meditators practice 10 min of “thinking of nothing” and “qigong meditation”, the intracerebral localization of brain electric activity during the two meditation conditions was compared using sLORETA functional EEG tomography. 19 EEG electrodes were applied.</td>
<td>To assess EEG change during QG meditation</td>
</tr>
</tbody>
</table>

### Ho et al., 2011 [74]
<table>
<thead>
<tr>
<th>OS</th>
<th>Country</th>
<th>Age</th>
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<th>Group</th>
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<th>Frequency Band</th>
<th>Effect of Meditation</th>
</tr>
</thead>
<tbody>
<tr>
<td>64</td>
<td>China</td>
<td>18-24</td>
<td>30M34F</td>
<td>NR</td>
<td>NR</td>
<td>28 had experience, 36 did not</td>
<td>Participants were assisted to enter QG state (relaxation, tranquility, naturalness) by given the sore feeling by acupuncturing.</td>
</tr>
</tbody>
</table>

### Qin et al., 2009 [38]
<table>
<thead>
<tr>
<th>OS</th>
<th>Country</th>
<th>Age</th>
<th>Gender</th>
<th>Group</th>
<th>Manual</th>
<th>Frequency Band</th>
<th>Effect of Meditation</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1 China</td>
<td>72-76</td>
<td>M</td>
<td>Masters&gt;25 yrs experience</td>
<td>NR</td>
<td>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, T5, T6, O1, and O2) with the Electro-Cap according to the 10-20 montage system referenced to linked earlobes.</td>
<td>To assess EEG changes after QG exercise</td>
</tr>
</tbody>
</table>

### Litscher et al., 2001 [29]
<table>
<thead>
<tr>
<th>OS</th>
<th>Country</th>
<th>Age</th>
<th>Gender</th>
<th>Group</th>
<th>Manual</th>
<th>Frequency Band</th>
<th>Effect of Meditation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Austria</td>
<td>M=58, F=47</td>
<td>1M1F</td>
<td>Master</td>
<td>NR</td>
<td>Recording EEG data follow the ABAB (Qigoing1, relaxation1, Qigoing2, relaxation2) experimental stages.</td>
<td>To compare the 0, α, 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&lt;.05), stage(F(1, 29)=6.72, p&lt;.05) and electrode (F(12, 29)=2.09, p&gt;0.05) between Qigong and control groups; 2. the EEG alpha band had main effect on group (F(12, 29)=0.09, p&gt;0.05) and electrode (F(1, 12)=50.14, p&lt;0.05) between both groups and group and electrode had interaction (F(1, 12)=3.44, p&lt;.05).</td>
</tr>
</tbody>
</table>

### Lee et al., 1997 [76]
<table>
<thead>
<tr>
<th>OS</th>
<th>Country</th>
<th>Age</th>
<th>Gender</th>
<th>Group</th>
<th>Manual</th>
<th>Frequency Band</th>
<th>Effect of Meditation</th>
</tr>
</thead>
<tbody>
<tr>
<td>M=25</td>
<td>Korea</td>
<td>13</td>
<td>7M6F</td>
<td>1-3 years</td>
<td>CDSSB</td>
<td>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.</td>
<td>To examine effect of QG on EEG patterns and activation coefficients</td>
</tr>
</tbody>
</table>

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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 more 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 from 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 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 during EQT than placebo sessions. Significant differences between two sessions for all electrode sites. (F3A1 placebo 28 vs. EQT32; F4A2 placebo 30 vs. EQT34; O1A1 placebo 32 vs. EQT 37; C2A2 placebo30 vs. EQT34; p<0.05).

Plasma cortisol concentrations were significantly lower during EQT than during placebo sessions (placebo 8 mg/dl vs. EQT 7.2 mg/dl; p<0.05).

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Location</th>
<th>Subjects</th>
<th>Type</th>
<th>Years of Practice</th>
<th>HbA1c (%)</th>
<th>Blood pressure (mmHg)</th>
<th>Plasma cortisol (ng/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Su et al., 2018 [43]</td>
<td>RCT</td>
<td>China</td>
<td>100</td>
<td>None</td>
<td>10</td>
<td>5.8</td>
<td>120/80</td>
<td>5.4</td>
</tr>
<tr>
<td>Kuo et al., 2003 [44]</td>
<td>OS</td>
<td>Taiwan</td>
<td>56</td>
<td>None</td>
<td>18-24</td>
<td>5.8</td>
<td>120/80</td>
<td>5.4</td>
</tr>
<tr>
<td>Zhang et al., 2004 [45]</td>
<td>QED</td>
<td>China</td>
<td>48</td>
<td>None</td>
<td>18.5</td>
<td>5.8</td>
<td>120/80</td>
<td>5.4</td>
</tr>
<tr>
<td>Liu et al., 2009 [46]</td>
<td>OS</td>
<td>China</td>
<td>21-54</td>
<td>None</td>
<td>1-20 yrs</td>
<td>5.8</td>
<td>120/80</td>
<td>5.4</td>
</tr>
<tr>
<td>Wang et al., 2011 [47]</td>
<td>ED</td>
<td>China</td>
<td>50</td>
<td>None</td>
<td>18.5</td>
<td>5.8</td>
<td>120/80</td>
<td>5.4</td>
</tr>
</tbody>
</table>

Table 2. Physiological/ CVD Detector Measurements of Qigong

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design</th>
<th>Population Characteristics</th>
<th>Methods</th>
<th>Outcome of Interests</th>
<th>Main Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chang et al., 2014 [79]</td>
<td>QED</td>
<td>Taiwan</td>
<td>24.1 ± 3.4; CON: 23.7 ± 3.1</td>
<td>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).</td>
<td>To examine the effects QG on the heart rate variability and peripheral vasomotor response of middle-aged and elderly people in the community.</td>
</tr>
<tr>
<td>Zhang et al., 2006[80] (In Chinese)</td>
<td>CT</td>
<td>China</td>
<td>55+</td>
<td>WQX and YJ</td>
<td>Participants practice WQX and YJJ twice a day, 40 minutes for each practice, last for 6 months. BP, HR, HI, SV, SWI, CO, CI, TPR, C, BW and BMI were tested at the beginning of the intervention, in the middle, and after intervention.</td>
</tr>
<tr>
<td>Lee et al., 2005 [81]</td>
<td>OS</td>
<td>Korea</td>
<td>M</td>
<td>None</td>
<td>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.</td>
</tr>
<tr>
<td>Lim et al., 1993 [82]</td>
<td>OS</td>
<td>U.S.</td>
<td>20.50 ± 1.84</td>
<td>None</td>
<td>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.</td>
</tr>
<tr>
<td>Sun et al., 1992 [83] (In Chinese)</td>
<td>OS</td>
<td>China</td>
<td>57.8 ± 8.8</td>
<td>Heart rate (HR) were recorded when practitioners were performing 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 (CG), D-Cancer-removing Gong.</td>
<td>To test effects of 4 QG breathing pattern on variability of heart rate.</td>
</tr>
</tbody>
</table>
**Blood Pressure**

<table>
<thead>
<tr>
<th>Study</th>
<th>OS</th>
<th>Country</th>
<th>Age Range</th>
<th>Intervention</th>
<th>Control</th>
<th>Practice Details</th>
<th>Blood Pressure Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lan et al., 2004</td>
<td>OS</td>
<td>Taiwan</td>
<td>59.1-66.6</td>
<td>36M</td>
<td>36M</td>
<td>Measure cardiorespiratory function during subsequent bicycle exercise test: 3 groups - QG (n=12), TCC (n=12), Sedentary (n=12)</td>
<td>SBP 120 ± 7 vs. 114 ± 7; DBP 78.09 ± 10.23; HR 76.03 ± 10.31</td>
</tr>
<tr>
<td>Zeng et al., 2013</td>
<td>RCT</td>
<td>China</td>
<td>60-79</td>
<td>QG: 86.32 (7.61), 60-79; C: 64.68 (8.25), 60-79</td>
<td>None</td>
<td>Participants were divided into two age groups: 60-69, 70-79. BP were measured after 5-10 minutes after performing relaxation.</td>
<td>No significant changes in DBP, SBP, and HR between intervention and control groups.</td>
</tr>
<tr>
<td>Lin and Huang, 2013</td>
<td>RCT</td>
<td>China</td>
<td>60+</td>
<td>QG: 31M, 37F; C: 27M, 32F</td>
<td>None</td>
<td>Intervention N=68 Use medicine to control hypertension, meanwhile practice WQX at least 6 times a week, 30 minutes for each practice.</td>
<td>No significant changes in SBP, DBP, and HR between WQX intervention and control groups.</td>
</tr>
</tbody>
</table>

**Note:** TCC refers to Taichi Chuan Chan, a traditional Chinese martial art. QG refers to Qigong. WQX refers to Wu Qiu Xing. RCT refers to Randomized Controlled Trial.
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<table>
<thead>
<tr>
<th>Study</th>
<th>Type</th>
<th>Country</th>
<th>Group</th>
<th>Participant Details</th>
<th>Intervention Details</th>
<th>Primary Outcomes</th>
<th>Additional Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lee et al., 2003 [87]</td>
<td>RCT</td>
<td>Korea</td>
<td>58: QG 29, CON 29</td>
<td>Male: 60-69</td>
<td>Block randomization</td>
<td>10 weeks, 3x/wk, 30 minutes</td>
<td>To test the effects of QG on BP</td>
</tr>
<tr>
<td>Cheung et al., 2005 [88]</td>
<td>RCT</td>
<td>HK</td>
<td>8</td>
<td>Male: 60 China</td>
<td>QG: 21M, 26F, C: 16M, 25F</td>
<td>16 wk (120 min × 4 weeks with a QG instructor or physiotherapist)</td>
<td>To test the effects of QG versus exercise on BP</td>
</tr>
<tr>
<td>Lee et al., 2004 [89]</td>
<td>RCT</td>
<td>Korea</td>
<td>36</td>
<td>Male: 60</td>
<td>QG exercise on blood lipid metabolism of elder intellectuals</td>
<td>TG, TC, HDL-C, LDL-C</td>
<td>To test the effects of QG on BP</td>
</tr>
<tr>
<td>Sun et al., 2008 [90]</td>
<td>Three-Arm RCT</td>
<td>China</td>
<td>60</td>
<td>Male: 60</td>
<td>TG, TC, HDL-C, LDL-C</td>
<td>To investigate the influence of different exercise methods on the blood lipid and physical function of male senior people in healthy adults</td>
<td></td>
</tr>
</tbody>
</table>

### Blood Lipids

<table>
<thead>
<tr>
<th>Study</th>
<th>Type</th>
<th>Country</th>
<th>Group</th>
<th>Participant Details</th>
<th>Intervention Details</th>
<th>Primary Outcomes</th>
<th>Additional Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Li et al., 2013 [50] (In Chinese)</td>
<td>CT</td>
<td>China</td>
<td>48</td>
<td>Male middle age group: 56.8 (2.3) Female middle age group: 57.4 (2.47) Male senior group: 66.5 (2.28) Female senior group: 65.2 (2.28)</td>
<td>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.</td>
<td>Explore the effect of QG exercise on blood lipid metabolism of elder intellectuals</td>
<td>After 8 weeks of intervention, there appeared a trend of improvement of blood lipid metabolism for both men and women. There seem to be a gender difference for the outcome in this study that women, in general, improved more significantly than men. For middle age female participants, HDL-C and LDL-C improved significantly; for senior female participants, TC, TG, HDL-C and LDL-C improved significantly; for middle age male participants, HDL-C and LDL-C improved significantly; for senior male participants, TG, HDL-C and LDL-C improved significantly.</td>
</tr>
</tbody>
</table>
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 a 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, TG, HDL-C and LDL-C improved significantly; for middle age male participants, only HDL-C improved significantly; for senior male participants, TC, 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): 146.9 ± 40.2 vs. 173.5 ± 31.2
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): 134.6 ± 27.1 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 [91] RCT 36 Korea QG: 52.6 ± 5.1; Control: 54.3 ± 5.5 QG: 8M9F; Control 6M13F None SXPXG Hypertensive patients were randomly divided into either the QG group (N=23), or a wait-listed control group (N=24). During 8-week study, QG 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 QG group after eight weeks compared with before (SBP 152 to 238, p< .001; QG 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 QG 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 QG 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 24 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 antibiotics 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-a, or ACTH. A direct observational study in Hong Kong reported an increase of IL6 at seven weeks of Qigong practice and that TNF-a 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) 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 neurohumoral 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 neurohumoral 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, neurohumoral 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 neurohumoral 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 preventions 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 any other 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

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Study Design</th>
<th>Population Characteristics</th>
<th>Methods</th>
<th>Outcome of Interests</th>
<th>Main Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Biochemical Parameters</strong></td>
<td></td>
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</tr>
<tr>
<td>Vera et al., 2007 [92]</td>
<td>RCT</td>
<td>Spain</td>
<td>29</td>
<td>25M, 2F</td>
<td>None</td>
</tr>
<tr>
<td>Miao et al., 2009 [93] (In Chinese)</td>
<td>RCT</td>
<td>China</td>
<td>50</td>
<td>14M15F</td>
<td>None</td>
</tr>
<tr>
<td>Liang et al., 2014 [94] (In Chinese)</td>
<td>RCT</td>
<td>China</td>
<td>60</td>
<td>25M, 25F</td>
<td>None</td>
</tr>
<tr>
<td>Liu et al., 2010 [95] (In Chinese)</td>
<td>RCT</td>
<td>China</td>
<td>62</td>
<td>20M, 20F</td>
<td>None</td>
</tr>
<tr>
<td><strong>Glucose</strong></td>
<td></td>
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</tr>
<tr>
<td>Liu et al., 2010 [1]</td>
<td>OS</td>
<td>Australia</td>
<td>11</td>
<td>42-65</td>
<td>None</td>
</tr>
</tbody>
</table>
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 (P < 0.003 and P < 0.001, respectively, by one-way ANOVA). AIC 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).

Youngpanichsuda 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, glycohemoglobin 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; 20 min 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.

Iwao 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).

Bilirubin

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<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Country</th>
<th>Age</th>
<th>Gender</th>
<th>Intervention</th>
<th>Control</th>
<th>Outcome Measures</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yang and Tao, 2015 [98] (In Chinese)</td>
<td>OS</td>
<td>China</td>
<td>M=69.8 (7.8), range 51-90</td>
<td>54M, 54F</td>
<td>None</td>
<td>BDJ</td>
<td>Participant practice BDJ 5-7 times per week, 35-40 minutes each time, last for 6 months. TBIL, DBIL and IBIL were tested before and after the intervention</td>
<td>To investigate the effect of BDJ on bilirubin level of type 2 diabetes patients</td>
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<tr>
<td>Inflammatory Markers</td>
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<tr>
<td>Oh et al., 2010 [99]</td>
<td>RCT</td>
<td>Australia</td>
<td>QG M= 60.1 (11.7); CON M: 59.9 (11.3)</td>
<td>NR</td>
<td>Modified from traditional QG</td>
<td>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</td>
<td>To evaluate the use of Medical Qigong compared with usual care to improve inflammation (Serum CRP) of cancer patients.</td>
<td>QG group significantly improved inflammatory marker serum C-reactive protein (CRP) (t=-2.042, p=0.044) compared with usual care after controlling for baseline variables. Mean difference between groups: -23.17 [-37.08, -9.26]</td>
</tr>
<tr>
<td>Oh et al., 2008 [100]</td>
<td>RCT</td>
<td>Australia</td>
<td>Age 35-75, M=54 (9)</td>
<td>8M22F</td>
<td>Modified from traditional QG</td>
<td>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: ~15 usual medical care</td>
<td>To evaluate the use of Medical Qigong compared with usual care to improve inflammation (Serum CRP) of cancer patients.</td>
<td>The QOL change scores from pre- to post-Medical Qigong intervention group were significant for global quality of life (student t=-3.989, p=0.005), cognitive function (student t=-2.646, p=0.033) and social function (student t=-2.393, p=0.048), but non-significant for physical function (student t=-1.000, p=0.351), role function (student t=-0.447, p=0.668), and emotional function (student t=-1.843, p=0.108)</td>
</tr>
<tr>
<td>Salivary Biomarkers</td>
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<tr>
<td>Chan et al., 2013 [101]</td>
<td>RCT</td>
<td>Singapore</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>QG was practiced twice a week by the study group (n = 18) while a control group (n = 16) had no intervention.</td>
</tr>
<tr>
<td>Sousa et al., 2012 [102]</td>
<td>Prospective Controlled Intervention</td>
<td>Portugal</td>
<td>QG M=11.5, SD=0.7; CON: M=12, SD=0.0</td>
<td>NR</td>
<td>None</td>
<td>WQ</td>
<td>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</td>
<td>To understand performance-related anxiety and physiological stress functions</td>
</tr>
<tr>
<td>Chow et al., 2012, [103]</td>
<td>OS</td>
<td>HK</td>
<td>M=44.2 SD=11.0</td>
<td>23M, 45F</td>
<td>None</td>
<td>CMG</td>
<td>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.</td>
<td>To measure stress reduction by salivary biomarkers and blood pressure</td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Participants</td>
<td>Intervention</td>
<td>Control</td>
<td>Outcome measures</td>
<td></td>
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<tr>
<td>Bayat-Movahed et al., 2008 [104]</td>
<td>OS</td>
<td>23</td>
<td>Iran</td>
<td>22-24</td>
<td>10M13F</td>
<td>None</td>
<td>YQG</td>
<td>The unstimulated saliva volume and pH were recorded every week in Spring (April, May, June) 2005 before the volunteers started to learn and exercise Qigong, and after Qigong intervention in Spring (April, May, June) 2006. Parameters of unstimulated saliva, including volume, pH, and secretory immunoglobulin A (S-IgA) level were measured. To measure effects of a Qigong program on various salivary parameters. The unstimulated saliva volume after Qigong exercises (2.94±0.20 mL/5min) was significantly higher as compared to the pre Qigong phase (1.65±0.12 mL/5min, P&lt;0.01). The saliva pH was 7.11±0.137 for the measurements and 6.980±0.087 for the second measurements, and the difference was statistically significant. 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&lt;0.005).</td>
</tr>
<tr>
<td>Lee et al., 2003 [59]</td>
<td>RCT</td>
<td>60</td>
<td>Korea</td>
<td>Intervention: 37 (Con: 35 ± 17)</td>
<td>NR</td>
<td>None</td>
<td>CDSB</td>
<td>Double blinded: Participants were randomized to a Qi-training group (n = 30) and sham QG control group (n = 30). Immune cell numbers were measured pre-intervention, immediately after the last session of the training program ended. To compare sham QG (placebo: without intention of gathering or moving Qi) with real QG. To explore the effect of WQX exercise on NK cell activity of senior adults. Paired t-tests show that White blood cells increased significantly 2 hours after actual QG. There were no significant effects on neutrophils.</td>
</tr>
<tr>
<td>Yu et al., 2008 [105] (In Chinese)</td>
<td>RCT</td>
<td>100</td>
<td>China</td>
<td>QG M=46, CON M=50</td>
<td>QG 12M, 34F, CON 15M, 35F</td>
<td>None</td>
<td>WQX</td>
<td>NK cell activity was tested at the beginning of the intervention and after the intervention. QG participants practice QG at least 4 times a week, 30 minutes each time for 6 months. Con: Daily life were kept as usual. To examine acute effect of QG on the counts of innate and adaptive immune cells in human peripheral blood after 1 month of QG practice.</td>
</tr>
<tr>
<td>Vera et al., 2015 [106]</td>
<td>RCT</td>
<td>43</td>
<td>Spain</td>
<td>18-21</td>
<td>9M 34F</td>
<td>None</td>
<td>DQ</td>
<td>25 participants were randomly allocated to the experimental group and 18 to the control group. The experimental subjects underwent daily qigong training for 1 month. Blood samples for the quantification of immune parameters (number and percentage of monocytes, neutrophils, eosinophils, total lymphocytes, B lymphocytes, and natural killer (NK) cells) were taken the day before the experiment commenced and 1 h after the last session of the training program ended. To examine acute effect of QG on the counts of innate and adaptive immune cells in human peripheral blood after 1 month of QG practice.</td>
</tr>
</tbody>
</table>
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| Lee et al., 2005 [107] | RCT | 18 | Korea | Experimental: 26.8 ± 1.2; control: 26.1 ± 1.7 | M | None | CDSB | 9 experimental subjects did 1 h of QG under a master; consisted of 10 min resting, 15 reciting; 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 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 | CSEH Experimental Qi | M | None | CDSB | 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 (g/dl): QTN pre 7.4 (6.1-8.5), post I 5.8 (5.4-7.2), 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). Melatonin (pg/ml) QTN: pre 7.2 (5.9-7.8), post I 7.1 (6.0-7.5), post II 5.0 (4.6-5.7), p<0.039. Superoxide generation (107 cpm) QTN: pre 3.7 (2.9-4.1), I 4.3 (3.4-5.4), post II 3.5 (2.9-4.3), p<0.001. 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<0.05. NK Cell (%) QTN pre 44.2 (40.5-51.1), post I 66.9 (54.2-78.6), post II 49.9 (45.0-61.3), p<0.001 QTT pre 44.8 (37.3-58.1), post I 55.9 (46.5-70.5), post II 49.4 (40.6-52.8), p<0.01 |
| Lee et al., 2005 [57] | OS | 10 | Korea | M=66 SD=3 | NR | None | CDSB | 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 Pre samples (Pre: 0.38 ± 0.9 ng/ml; Post: 0.66 ± 0.8, p<.001). 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±1.92, Younger age M=26.58±1.03 | 14M, 12F | 0.6 year of experience | CDSB | 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 ChunDoSunBup (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 <.05) in the elderly trainees and by 1.66 fold (p <.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. |
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To examine the acute effect of QG on the plasma level of growth hormone (GH), insulin-like growth factor (IGF)-I and insulin like growth factor

The plasma level of GH at the mid-time (40 min) has significantly increased (2.16±0.48 ng/ml, P=0.05) compared to the level at pre-time of QG (1.26 ± 0.37 ng/ml). The plasma level of IGF-I was significantly increased at the mid-time (286.40±15.97 ng/ml) compared to the pre-time of QG training (245.57 ± 13.90 ng/ml, P=0.05) There was a significant correlation between the levels of GH and IGF-I immediately after QG training (r=0.69, P=0.01). There was a relative shift in IGFBP-3 for the 43-kDa fraction during mid-time of QG-training (P=0.05)

Assess the effects 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.

To understand the change of T-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; maximal 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 (QG: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 (QG:72.7 in 24hr. 72.7 in 48 hr, 57.1 in 72 hr vs. CON 18.2 in 24hr, 16.7 in 48 hr, 12.5 in 72 hr) were higher in QG in than control. QG group had larger duration size than control (p<0.05)
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/ml): 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 M0.57 ± 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, 6M 9.81 ± 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  
To examine the plasma levels of GH and IGF-I, 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)

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 investigate the immunological effects of Qi-training, and investigate the effects of Qi-training on the HPA axis  
To examine the QG training on the plasma levels of GH and IGF-I, ACTh cortisol, and DHEA-S response to Qitraining  
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 Qi-training [Pre, that is 10 min before Qi-training] and immediately after the Qi-training [Post, within 10 min (+10 min)].  
To examine the plasma level of beta-endorphin, ACTh cortisol, and DHEA-S response to Qi training  
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 compared to pre-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  
To investigate how systemic treatment of CDSB on hormones on elderly subjects  
1) T3 concentrations increased (1.84 ± 0.07 to 1.93 ± 0.07 to 1.99 ± 0.07 nmol/L, p<0.05) at pre-, mid-, and post-training  
2) No significant differences in TSH (1.10 ± 0.20 to 1.16 ± 0.21 to 1.24 ± 0.22 uIU/ml), Calcitriol (7.41 ± 0.55 to 7.80 ± 0.63 to 8.24 ± 0.87 pg/ml), Calcium (8.99 ± 0.27 to 8.16 ± 0.27 to 8.34 ± 0.41), and pH (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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<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Country</th>
<th>Age</th>
<th>Gender</th>
<th>Group</th>
<th>Intervention</th>
<th>Sample Size</th>
<th>Duration</th>
<th>Outcome Parameters</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loe et al., 2003 [116]</td>
<td>RCT</td>
<td>Spain</td>
<td>18-21</td>
<td>14M</td>
<td>None</td>
<td>BDJ</td>
<td>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.</td>
<td>29</td>
<td>1 month</td>
<td>To examine the effect of QI-training on the immune system, especially neutrophil bactericidal function.</td>
</tr>
<tr>
<td>Manzaneque et al., 2004 [60]</td>
<td>RCT</td>
<td>2005 [61] (In Chinese)</td>
<td>China</td>
<td>45-65</td>
<td>21M, 23F</td>
<td>None</td>
<td>BDJ</td>
<td>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.</td>
<td>44</td>
<td>10 weeks</td>
</tr>
<tr>
<td>Yang et al., 2007 [6]</td>
<td>RCT</td>
<td>U.S.</td>
<td>M=77.2 SD=1.3</td>
<td>None</td>
<td>None</td>
<td>NR</td>
<td>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.</td>
<td>50</td>
<td>20 weeks</td>
<td>To analyze the effect BDJ on the immune system, especially neutrophil bactericidal function.</td>
</tr>
</tbody>
</table>
due to the ineffectiveness of the type of Qigong. 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 physical interactions [64]. While current technological advances help us better assess the efficacy of devices, further research on Qi energy could benefit from the words such interactions mainly focuses on the mechanical interactions. Vital energy, or Qi, is posed as the solution to such ailments; in other words the practitioner’s experience; while researchers consider this an ‘information’ into tissues [65]. While researchers consider this an

<table>
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<tr>
<th>Reference</th>
<th>Year</th>
<th>Country</th>
<th>Group A</th>
<th>Group B</th>
<th>Exercise Duration</th>
<th>Post-Exercise Measurements</th>
<th>Hemodynamics Before WTK</th>
<th>Hemodynamics After WTK</th>
<th>HRV Measures</th>
<th>Statistical Test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lu et al., 2006</td>
<td>90</td>
<td>QED</td>
<td>Taiwan</td>
<td>TCC: 53.0 (41-71); WTK: 58.5 (48.0-70.0); Control: 56.4 (32-72)</td>
<td>TCC: 14M16F; WTK: 12M18F; Control: 7M23F</td>
<td>TCC: 2.0yr experience; WTK: 2.3 yr experience; Control: 0 yr</td>
<td>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, 30 min cool down); WTK: 40 min in duration (5 min warm up, 35 min cool down). 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</td>
<td>To compare the effects of TCC and WTK on autonomic nervous system modulation and on hemodynamics</td>
<td>Kruskal-Wallis one-way analysis of variance on ranks was utilized. Comparing 30 and 60 min after WTK and TCC. The mean RR (RR intervals) (WTK 30 min: 0; 60 min:6; TCC 30min:3; 60 min:6; p&lt;0.05), SDRR (Standard deviation of RR) (WTK 40-60; 60 min:2%; TCC 30min:1%; 60 min:13%; p&lt;0.05), and HF (high frequency power) significantly increased (WTK 30 min: 21; 60 min:47; TCC 30min:27; 60 min:35;p&lt;0.05), whereas the heart rate (WTK 30 min: 0.2; 60 min:5.4; TCC 30min:7.6; 60 min:5.7; p&lt;0.05), and LF (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&gt;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.</td>
<td></td>
</tr>
<tr>
<td>Lu WA et al., 2003</td>
<td>QED</td>
<td>40</td>
<td>Taiwan</td>
<td>WTK: 58.1 ± 5.9; CON: 55.9 ± 8.3</td>
<td>14M26F</td>
<td>20 in WTK, 20 in control group</td>
<td>To evaluate the effect of WTK on autonomic nervous system modulation in the elderly</td>
<td>The stationary state spectral heart rate variability (HRV) measures, hemodynamics, and spirometry between the WTK group and normal controls and sequential changes in HRV measures and hemodynamics after WTK were compared, using Mann-Whitney rank sum test. We found that the standardized deviation and coefficient of variation of RR intervals, total power, low frequency power (LFP), and normalized LFP (nLFP) in WTK practitioners before WTK were all significantly higher than those of normal controls. After WTK, the normalized high-frequency power increased (nHFP) significantly from 27.7 ±13.2 normalized units (nu) before WTK to 37.6 ±16.0 nu at 30 min after WTK, and to 39.8 ±20.1 nu 60 min after WTK. In contrast, LFP/HFP decreased significantly from 1.3 ±1.0 before WTK to 1.0 ±0.9 30 min after WTK and to 0.8 ±0.6 60 min after WTK.</td>
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<td></td>
</tr>
</tbody>
</table>

1 TC=total cholesterol, TG=triglyceride, HDL-C=high-density lipoprotein cholesterol, LDL-C=low-density lipoprotein cholesterol
2 TC=total cholesterol, LDL-C=low-density lipoprotein cholesterol, HDL-C=high-density lipoprotein cholesterol, SOD=superoxide dismutase
3 GIH-Px=glutathione peroxidase, MDA=plasma malondialdehyde; YJJ: Yi-Jing-Jing
4 TBL=total bilirubin, DBIL=direct bilirubin, IBIL=indirect bilirubin
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, specifically 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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