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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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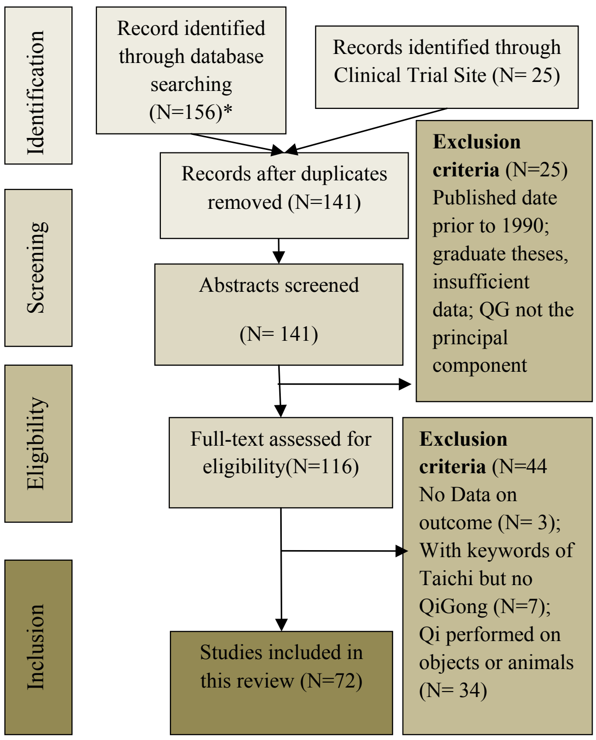
for more understanding of Qigong therapy, the purpose of this review paper is to address critical measurement issues pertaining to Qigong research. The aims of this review are to understand 1) the physical and biological detector measurement of Qigong; 2) the physiological detectors of Qigong; 3) research 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 training, 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 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.



**Key words: Qigong, Qi therapy, Qi training, Qi practice, bioenergy Qi detectors*

Figure 1. Literature Selection Flow Chart.

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 inquires. 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**
		#	**Country**	**Age**	**Sex**	**Previous QG Practice**	**Type of QG**			
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	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).
Biomagnetic Measurement										
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 wound 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 pain 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=29.9	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 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 < 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										

Faber *et al.*, 2012 [37]	OS	8	Taiwan	M= 41.5; SD=10.4 Range=30-56	3M 5F	Masters	Master Feng-San Lee's QG	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.	To assess EEG change 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	64	China	18-24	30M34F	28 had experience, 36 did not	NR	Participants were assisted to enter QG state (relaxation, tranquility, naturalness) by given the sore feeing by acupuncturing.	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 33.31 ± 0.13c to 33.79 ± 0.24; electromyogram from 9.4 ± 4.3to 116.5 ± 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 65.5 ± 14.3; heart rate pulse/min from 72.9 ± 8.6to 70.8 ± 11.9
Qin *et al.*, 2009 [38]	OS	3	1 China 2 U.S.	72-76	M	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, CZ, 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.	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 rest state 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, P3-P4 increased from 0.7 to 0.8 during meditation.
Fong *et al.*, 2004 [75]	OS	30	NA	NA	NR	Half masters, half no-experience	NR	Recording EEG data follow the ABAB (Qigoing1, relaxation1, Qigoing2, relaxation2) experimental stages.	To compare the θ, 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<.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)=l2.09, p<.05) and electrode (F(1, 12)=50.l4, p<.05) between both groups and group and electrode had interaction (F(1, 12)=3.44, p<.05)
Litscher *et al.*, 2001 [29]	OS	2	Austria	M=58, F=47	1M1F	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	M=25 (20-32)	Korea	13	7M6F	1-3 years	CDSB	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.

Lee *et al.*, 1994 [47]	RCT	10	Korea	23.19 ± 3.44	NR	None	CDSB	Participants attended crossover sessions either in Qi or placebo with eyes open . One 30-yearold master with 8 yr of practice emitted Qi from head to body on subjects in External Qi Therapy (EQT) group, for placebo group he mimics the gestures used in the actual EQT with no effort or intention to emit real Qi.	To assess the effect of external Qi on changes of EEG and circulating cortisol concentrations, and emotional states	The emotions of satisfaction (Placebo 0.43 ± 0.98 *vs.* EQT 0.86 ± 1.07, $p<0.05$) and relaxation (Placebo 0.43 ± 0.53 *vs.* EQT 0.43 ± 0.53, $p<0.001$) 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; O2A2 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; $p<0.05$)
EMG										
Kuo *et al.*, 2003 [77]	OS	56	Taiwan	18-24	20M 36 F	None	NQ	Physiological changes are assessed with EEG in the right frontal lobe of cerebrum, finger pylse 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)	Once entering QG state, appearance of EEG pattern and temperature rise (17.9 in control, to 31.7 in QG), change in EMG (7.9 in control, 126.7 in QG state), SCL (13.5 in control; 31.2 in QG state), FPA (31.4 in control, 64.5 in QG)
Wirth *et al.*, 1997 [78]	Double-blind RCT	44	China	NR	NR	Half experience, half none	NR	3 groups- students of QG/students of therapeutic touch (TT)/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	Significant rise in sEMGfor QG group during intervention segment ($p<0.024$); Treatment Effect of QG group from baseline to treatment: 3.65 t07.5; whereas control of TT decreased from 3.4 o 3.4, and non-believers remained the same at 3.4
Evoked Potential Tests										
Zhang *et al.*, 1993 [40]	QED	48	China	G1: 61.9 ± 8.5, G2:48.5 ± 15.1, G3: 54.3 ± 11.6, G4:49.0 ± 12.1	NR	NR	NQ	Flash visual evoked potentials (F-VEPs) were recorded from the occipital scalp: Group 1)14 NQ practitioners for 0.5-5.5 yrs. 2) 12 NQ practitioners for 0.5-3 m; 3) 11 none-practitioners; 4) 11 QG (non-specified) practitioners	To investigate the functional state of the cerebral cortex during QG meditation	QG meditation may have either facilitative or inhibitory effects on visual cortex depending on which QG practice. F-VEP amplitudes increased in Group1 (N_{80}-P_{115}- N_{150} increased by 2,3 ± 3.4 uv , $p<0.05$; N_{150}-P_{200}-N_{280} increased by 5.1 ± 5.1 uv, $p<0.001$), decreased in group 4 (N_{150}-P_{200}-N_{280} decreased by 3.8 ± 3.8 uv, $p<0.05$), No significant changes in group 2 ($p>0.05$).
Liu *et al.*, 1990 [41]	OS	NR	China	21-54	NR	1-20 yrs experience	NR	Evoked potentials measured before, during, after QG, through Short Latency Auditory Evoked Potentials (LAEP)	To investigate the effect of QG on short-latency auditory brainstem evoked response (ABER, <10ms), middle-latency response (MLR, 10-50 ms), long-latency auditory evoked potentials (AER, 50-200 ms)	Significant increases of amplitudes of waves from 55to 61% ($p<0.05$) for waves I-III, 70-76% for waves IV and V ($p<0.001$). Waves VI and VII showed little change (+5.9%, -9.5%, $p>0.05$). Mean latencies of ABER (n=21), MLR(n=11), AER(n=11) showed no significant changes as a result of QG. (Statistical Method NR)

*OS: Observational Study; RCT: Randomized Clinical Trials; QED: Quasi experimental design; ED: Experimental design; EQ: External Qigong; WB: White Ball Standing, QiGong; BDJ: Bah-Duan-Jin; GL: GuoLin Qigong; NQ: Neiyang Qigong; SXPXG: Shu-xin-pin-xue-gong; DD: Dharma Drum's eight-form moving meditation; HQ: Healthy Qigong; NR: Non-reported

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 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 correlate with the value of heart rate variability parameters [43]. It is important to note that these study discrepancies may be explained by various Qigong training styles, length of each program, and exercise frequency and intensities [44].

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			
Heart Rate										
Chang *et al.,* 2014 [79]	QED	77	Taiwan	QG: 63.0 ± 6.4; CON:65.1 ± 7.4	17M60M	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 QG on the heart rate variability and peripheral vasomotor response of middle-aged and elderly people in the community	The t-test and the $\chi 2$ 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. BP, 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,HI,SV,SW,SWI,CO,CI,TPR and C for 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 female participants, SBP, DBP, SV, CO,CI,TPR 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- heartrate 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/Hz) QG: 51.3 ± 13.6 to 65.6 ± 16.1. CON: 54.8 ± 14.6 to 58.0 ± 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	12M 6F	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 (CG), 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(0.63hz), and HG (0.66), compared to normal breathing (2.66 hz, $p<0.05$) indicating the vagal activity increased QG breathing pattern.
Pulse										

Lan *et al.*, 2004 [84]	OS	36	Taiwan	59.1 (6.6)	36M	QG: practice for 2.3 (1.5) years TCC : practice of 4.7 (2.3) years	NR	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 (9.1 ± 2.2 *vs.* 7.2 ± 1.3, p<.05). No significant difference in work rate (60 ± 20 *vs.* 55 ± 13, p=NS)
Jones *et al.*, 2001 [45]	OS	19	HK	27-55	8M11F	None	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. IFNgamma-secreting cells increased and IL10-secreting cells decreased in PHA-stimulated cultures, resulting in significant increases in the IFNgamma:IL10 ratio. Cortisol, a known inhibitor of type 1 cytokine production, was reduced by practicing QG
Blood Pressure										
Lee *et al.*, 2000 [46]	OS	12	Korea	28 ± ‹ 9	9M3F	1.3 ± 0.2 yrs	CDSB	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 sound training: 71 ± 6, mid-meditation: 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	120; 60 in intervention; 60 in control	China	QG: 66.32 (7.61), 60-79 C: 64.68 (8.25), 60-79)	QG: 28M, 32F C: 31M, 29F	None	FSG	Participants were divided into two age groups :60-69;70-79. BP[1] 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[2] 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	127	Hefei, China	60+	QG: 31M, 37F C: 27M, 32F	None	WQX	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 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.,* 2003 [87]	RCT	58; QG 29. CON 29	Korea	QG:56 (5.9) C: 56.5 (7.2)	NR	NR	NR	QG: Block randomization 10 weeks, 3x/wk, 30 minutes QG with expert. Wait list control n=29	To test the effects of QG on BP	Qigong significantly lowered BP compared to control: Systolic BP: significant group-by-time interaction [F(5, 280) = 6.70, p < .001] Diastolic BP: significant group-by-time interaction [F(5, 280) = 2.23, p < .05]
Cheung *et al.,* 2005 [88]	RCT	8	HK	QG: 57.2 (9.5) C: 51.2 (7.4)	QG: 21M, 26F C: 16M, 25F	NR	GL	16 wk (120 min × 2 days × 4 weeks with a QG instructor or physiotherapist, then monthly and encouraged to practice 60 min in AM and 15 min in PM × 7 days). CON: Exercise of stretching, walking, and pressure-relieving activities similar to QG	To test the effects of QG versus exercise on BP	Similar effects of Guolin QG and convention exercise. SBP and DBP decreased in both groups by week 16 (P<0.001). The differences in SBP reduction between the two groups: 0.59 mmHg (95% CI: -3.73, 4.91; P=0.79) The differences in DBP reduction between the two groups: 1.83 mmHg (95% CI: -0.75, 4.41; P=0.16).
Lee *et al.*, 2004 [89]	RCT	36	Korea	QG: 52.6 (5.1) C: 54.3 (5.5)	NR	None	SXPXG	QG: 8 wk (30 min × 2 days/wk). Wait list control N=19	To test the effects of QG on BP	After 8 weeks, SBP and DBP of Qigong group were significantly different to the control (SBP: p <0.001; DBP: p <0.001). Significant changes in SBP and DBP in qigong group after 8 weeks (SBP: 152.0 ± 10.5 *vs.* 137.3 ± 7.5, p <0.001; DBP: 97.2 ± 6.5 *vs.* 83.6 ± 6.2, p <0.001) and in DBP in the control group (93.8 ± 6.2 *vs.* 96.8 ± 4.6, p<.001).
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	NR	TG, TC,HDL-C,LDL-C [3] ere tested at the beginning the intervention and after the intervention QG participants first received 1 week of BDJ tutoring, after the training session each participant practice BDJ 5 days a week, 30-40 minutes each time. Last for 3 months QG group: N=20 running group: N=20 Control Group: N=20	To investigate the influence of different exercise methods on the blood lipid and physical function of male senior people in healthy adults	Compare with control group, there's a statistically significant improvement of TG, LDL-C, HDL-C among intervention group. (p<0.05) TG: 1.2 ± 0.13 *vs.* 4.73 ± 0.57 HDL-C:1.7 ± 0.28 *vs.* 1.51 ± 0.19 LDL-C2.31 ± 0.22 *vs.* 2.72 ± 0.75(2.69 ± 0.71) TC=total cholesterol, TG= triglyceride LDL-C=low-density lipoprotein cholesterol, HDL-C=high-density lipoprotein cholesterol
Blood Lipids										
Li *et al.,* 2013 [50] (In Chinese)	CT	48	China	Male middle age group: 56.8 (2.13) male senior group: 67.7 (2.14) female middle age group: 57.4 (2.47) female senior group: 66.5 (2.28)	24M 24F	None	HQ	Participants practice QG 1 hour each day, last for 8 weeks; TC, TG, HDL-C and LDL-C were tested at the beginning the intervention and after the intervention.	To explore the effect of QG exercise on blood lipid metabolism of elder intellectuals	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. Middle age female: TC: 4.85 ± 0.52 *vs.* 4.88 ± 0.55 TG: 1.25 ± 0.28 *vs.* 1.64 ± 0.41 HDL-C: 1.73 ± 0.34 *vs.* 1.41 ± 0.28* LDL-C: 2.53 ± 0.4 *vs.* 2.93 ± 0.51* senior female: TC: 5.4 ± 0.28 *vs.* 5.82 ± 0.42* TG: 1.24 ± 0.21 *vs.* 1.7 ± 0.27* HDL-C: 2.02 ± 0.18 *vs.* 1.36 ± 0.18* LDL-C: 2.68 ± 0.28 *vs.* 3.44 ± 0.22* Middle age male: TC: 4.38 ± 0.45 *vs.* 4.55 ± 0.52 TG: 1.25 ± 0.2 *vs.* 1.31 ± 0.23 HDL-C: 1.55 ± 0.07 *vs.* 1.37 ± 0.22* LDL-C: 2.27 ± 0.18 *vs.* 2.54 ± 0.18* senior male: TC: 4.57 ± 0.52 *vs.* 4.63 ± 0.53 TG: 1.17 ± 0.11 *vs.* 1.41 ± 0.12* HDL-C: 1.67 ± 0.11 *vs.* 1.4 ± 0.05* LDL-C: 2.31 ± 0.15 *vs.* 2.64 ± 0.21*

Chen and Chen, 2015 [51] (In Chinese)	Trial	65	China	Middle age group: 54.8 (4.3), 49-60 Senior Group:65.2 (4.6), 61-70	30M 35F	None	BDJ	At the beginning of the intervention participants received 1 week Taichi and BDJ training. Participants then practice Taichi and BDJ no less than 3 hour per week, at least 40 min each time. Last for 3 months Participants were divided into 4 subgroup based on their gender and age. TC, TG, HDL-C,LDL-C and SF 36 were tested at the beginning the intervention and after the intervention.	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, 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.* 166.3 ± 48.6 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 (QG SBP 152 to 238, p< .001; QG DBP 98 to 84:p< .001). There was also significant change in the DBPof 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.

[1]BP=Blood Pressure, HR=Heart Rate, ISH=isolated systolic hypertension
[2]SBP=systolic blood pressure DBP=diastolic blood pressure DP=Double Product
[3]TC=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 on 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) 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 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 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 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
		#	Country	Age	Sex	Previous QG Practice	Type of QG			
Biochemical Parameters										
Vera *et al.,* 2007 [92]		29	Spain	18-21	14M15F	None	BDJ	16 in QG, 13 in control. QG subjects were submitted to a qigong training program for a period of one month, practicing qigong for 30 minutes. Blood sample were taken before and after QG.	To analyze the effects of a qigong training program on blood biochemical parameters of GOT (glutamic-oxaloacetic transaminase), GPT (glutamic-pyruvic transaminase), urea GGT (gamma-glutamyltransferase)	A between-group analysis of covariance shows that the effects of experimental treatment after adjustment for covariants were found for GOT (U/L) QG: 16.7; Control: 21.4[F(1,22)=10.7, p=.003], GPT (U/L) QG: 16.4. Control: 20.7. [F(1,22)=4.32, p=.04], urea (mg/dl) QG: 27.6, Control: 33.2 [F(1,22)=6.51, p=.02]. No significant effects were found for total cholesterol [F(1,22)=1.12, p=.30], high-density lipoprotein [F(1,22)=1.55, p=.22], low-density lipoprotein [F(1,22)=0.07, p=.78], triglycerides [F(1,22)=0.81, p=.37], phospholipids [F(1,22)=1,47, p=.23], and creatinine [F(1,22)=0.52, p=.47]
Miao *et al.,* 2009 [93] (In Chinese)	RCT	50	China	QG group: 63.32 (6.35) Control Group: 63.68 (6.8)	25M, 25F	None	BDJ	BP,TG, TC,HDL-C,LDL-C were tested at the beginning the intervention and after the intervention QG participants first learned about BDJ and then practice QG 5-7 times per week, each time 50-60 minutes, last for 18 months QG: 25, CON: 25 life as usual	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)	QG: 20M, 10F C: 18M, 12F	None	BDJ	TG, TC,HDL-C,LDL-C [1] were tested at the beginning the intervention and after the intervention 30 participants practice QG 5 days per week, twice each day, each practice last 20 minutes, last for 6 months	explore the effect of BDJ on BP and 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	65.7 (3.1), 62-69	All F	None	YJJ	TG, TC,HDL-C,LDL-C ,SOD,GSH-Px and MDA [2] 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 ± 12.78 GSH-Px : 167.14 ± 19.93 *vs.* 131.97 ± 20.38 MDA: 3.98 ± 0.64 *vs.* 4.62 ± 0.89
Glucose										
Liu *et al.,* 2010 [1]	OS	11	Australia	42-65	3M8F	None	KMQG	A single group pre- and post- trial; Participants with elevated blood glucose attended Tai Chi QG exercise training for 1 to 1.5 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 indictors 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, $p<0.05$),

Sun *et al.,* 2010 [53]	RCT	32	U.S.	M56.3, SD8.1	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).
Youngwanichsetha *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
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										

Yang and Tao, 2015 [98] (In Chinese)	OS	108	China	M=69.8 (7.8), range 51-90	54M, 54F	none	BDJ	Participant practice BDJ 5-7 times per week, 35-40 minutes each time, last for 6 months. TBIL,DBIL and IBIL[3] were tested before and after the intervention	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
Inflammatory Markers										
Oh *et al.,* 2010 [99]	RCT	162	Australia	QG M: 60.1 (11.7); CON M: 59.9(11.3)	QG M:31, 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.	QG group significantly improved inflammatory marker serum C-reactive protein (CRP) (t_{99}=2.042, P<0.044) compared with usual care after controlling for baseline variables. Mean difference between groups: -23.17(-37.08-.9.26)
Oh *et al.,* 2008 [100]	RCT	30	Australia	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: =15 usual medical care	To evaluate the use of Medical Qigong compared with usual care to improve inflammation (Serum CRP) of cancer patients	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)
Salivary Biomarkers										
Chan *et al.,* 2013 [101]	RCT	34	Singapore	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 [102]	Prospective Controlled Intervention	16	Portugal	QG M=11.5, SD=0.7; CON: M=12, SD=0.0	NR	None	WQ	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	Heart 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, [103]	OS	68	HK	M=44.2. SD=11.0	23M, 45F	None	CMG	The changes in outcomes over four repeated measures: pretest (week 1), midway (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=.048) and diastolic blood pressure (F[1,63]=4.37, p=.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=.013), diastolic blood pressure (F[1,63]=4.49, p=.038), and lower cortisol levels (F[1,62]=15.91, p

Bayat- Movahed *et al.,* 2008 [104]	OS	23	Iran	22-24	10M13F	None	YQG	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	To measure effects of a Qigong program on various salivary parameters	The unstimulated saliva volume after Qigong exercises (2.94d0.20 mL/5min) was significantly higher as compared to the pre Qigong phase (1.65d0.102 mL/5min, P. The saliva pH was 7.116d 0.137 for the measurements and 6.980d0.087 for the second measurements, and the difference was not statistically significant. The level of salivary S-IgA was 105.45 d69.41 mg/mL for the first measurement and 156.23 d 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).
Immune Parameters										
NK Cells										
Lee *et al.,* 2003 [59]	RCT	60	Korea	Intervention: 37 ± 12; Control: 35 ± 17)	NR	None	CDSB	Double blinded- Participants were randomized to a Qi-training group (who performed Qi-training; n = 30) and sham QG control group (who performed the same motions without gathering or moving Qi; n = 30). Immune cell numbers were measured pre-intervention, immediately post-intervention and 1 or 2 hours post-intervention	To compare sham QG (placebo: without intention of gathering or moving Qi) with real QG to investigate the effects of QG on immune cells, including NK , neutrophils, lymphocyte	Paired t-tests show that **White blood cells** increased significantly 2 hours after actual QG (Pre: 5.68 ± 1.36; post: 5.67 ± 1.32 ; 2-hr post: 6.12 ± 1.29; $p < 0.05$) but not sham training compared with pre-intervention. There were significant increases in **lymphocytes** 2 hours after actual but not sham QG (pre: 2.05 ± 0.52; post: 2.04 ± 0.51; 2-hr post: 2.20 ± 0.52; $p < 0.05$) and monocyte numbers were significantly increased immediately after both actual QG (pre: 0.44 ± 0.26 ; post: 0.67 ± 0.51; 2-hr post: 0.44 ± 0.16; $p < 0.01$) and sham training (pre: 0.40 ± 0.08; post: 0.44 ± 0.12; 2-hr post: 0.45 ± 0.11p < 0.05). **NK cell** numbers decreased significantly both immediately after QG and after sham movements done without concomitant Qi-training ($p < 0.01$). There were no significant effects on neutrophils.
Yu *et al.,* 2008 [105] (In Chinese)	RCT	100	China	QG M=46, CON M=50	QG 12M, 34F. CON 15M, 35F	None	WQX	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 explore the effect of WQX exercise on NK cell activity of senior adults	Compared with control group, there's a statistically significant improvement of NK cell activity among intervention group. Male: 29.04 ± 11.46 *vs.* 24.64 ± 8.43 Female: 27.86 ± 15.65 *vs.* 21.44 ± 7.78
Vera *et al.,* 2015 [106]	RCT	43	Spain	18-21	9M 34F	None	DQ	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	After 1 month: Differences were found between the experimental and control groups, with the experimental group showing higher NK cells values (234.62 cells/μl) compared to control group (195.51 cells/μl) in the number (p=0.006) and the percentage (10.72% *vs.* 9.40%; p=0.04) of B lymphocytes, as well as lower values in the percentage of NK cells (16.26% *vs.* 18.96%, p=0.05), as compared to control.

Lee *et al.,* 2005 [107]	RCT	18	Korea	Experiemental: 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 time × group interaction [F(2,32) = 6.3, 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 for16 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 External Qi	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 Wilcox 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 (10^7 cpm) QTN: pre 3.7 (2.9-4.1), post 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
- Growth Harmone										
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< .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+-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 < 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.

Ryu *et al.,* 2000 [58]	OS	16	Korea	M=29; contrl M=26	M	>6 months experience	CDSB	10 participants in QG, 6 in sedentary comparison group. Blood was drawn at rest, pre-time of Qi-training [that is 10 min before Qi-training (210 min)], at 40 min (the mid-time of Qi-training, the time between motions and meditation), and immediately after the Qi-training [within 10 min (+10 min)]	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 Qi-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 Qi-training (r=0.69, P,0.01). There was a relative shift in IGFBP-3 for the 43-kDa fraction during mid-time of Qi-training (P,0.05)
- Cytokines										
Manzaneque *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	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.
- 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-tailored 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 (2.39 ± 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/mm^3 more than in normal healthy group.
Yao *et al.,* 1989 [111]	OS	23	China	M=32(14-69)	8M5F	None	Various	10 in QG group who do 1-hr daily more than 1 month, combing 5 QG: breathing, stepping, meditation, kidney-enhancement. Control: patient aplastic anemia without QG practice	To understand the changes of T-cell with QG practice in patients with aplastic anemia	QG participants Th and the ratio of Th/Ts were greatly elevated than those without Qigong treatment (Leu 3n+: QG 38.3 ± 6.7, CON 29.1 ± 9.1, p<0.02; Leu 3n+/leu 2a+ QG 1.18 ± 0.41, CON 0.77 ± 0.29, p<0.02)
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 shoes the number of responded antigens and the size of induration in the positive skin test was different in QG group to control group; maximun 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, 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 chemo; 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, W3:5356. CON B: 6166, W2: 3661, W3:1955, W4:6236. F = 115.76, P<0 .001), platelets (QG Baseline: 246,228 microliters, W1: 194,523, W2: 217,222, W3: 312,000. CON: Base: 263,687, W1:189500. 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-B:12.75, W1:11.89, W2:11.42, W3:12.34. F = 15.39, P <0.001)

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 ± 0.03,6M 0.64 ± 0.02**, 9M 0.55 ± 0.01**, 12M 0.43 ± 0.02** LDL-c 3M0.57 ± 0.02, 6M 0.51 ± 0.03*, 9M 0.46 ± 0.01**, 12M 0.38 ± 0.01** HDL-c 3M1.23 ± 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 ± 0.09, 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	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' superoxide generation, and adhesion capacity	The plasma GH level was increased after Qi-training compared to pre Qi-training (p < .01). The plasma level of IGF-1 was significantly increased after Qi-training (p < .05). Superoxide generation was significantly enhanced after Qi-training compared to before Qi-training (p < .01). The adhesive capacity of neutrophils was significantly enhanced after Qi-training (p < .05). Significant priming of human neutrophils by GH was observed at 10 ng/ml (p < .05), 100 ng/ml (p < .01), and 250 ng/ml (p < .05). According to the dose-response curve, we selected one submaximal dose as 250 ng/ml (p < .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 mediation, and post-training 1 hour of qi-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 to 1.99 ± 0.07 nmol/l, p<.05) at pre-, mid-, and post-training. T4 concentrates increased (92.43 ± 5.68 to 99.8 ± 5.7 nmol/l, p<.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 uUI/ml), Calcitonin (7.41 ± 0.55 to 7.80 ± 0.63 to 8.24 ± 0.87 pg/ml), Calcium (8.99 ± 0.27 to 9.16 ± 0.21 to 8.54 ± 0.18), and pH (7.88 ± 0.03 to 7.86 ± 0.02 to 7.89 ± 0.02) at pre-, mid-, and post-training
Matabolism and Immune Functions										

Lee *et al.,* 2003 [116]	OS	9	Korea	M=26 ± 4	9M	Age 26 ± 4	CDSB	Subjects were studied for the effects of one bout of ChunDoSunBup (CDSB) Qi-training on superoxide (O2- production and adhesion capacity of neutrophils at times immediately after (Post I) and 2 hours after the Qi-training (Post II).	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 [$F(2, 16) = 14.31$, $p < 0.001$] and lymphocytes [$F(2, 16) = 4.6$, $p = 0.026$] 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 f nished, blood samples were drawn from all subjects for the quantify cation 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/ul)(QG:5.66, CON:6.73, $p<0.05$), Monocytes ($x10^3$ cells/ ul)(QG:0.45, CON:0.60, $p<0.05$), Eosinophiles ($x10^3$ cells/ul)(QG:0.19, CON:0.29, $p<0.05$), Monocytes ($x10^3$ cells/ ul)(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 nitricoxide, 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 particpants = 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	Sgnificant 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.
Nervous System										

Lu *et al.,* 2006 [118]	QED	90	Taiwan	TCC: 53.0 (41-71); WTK: 58.5(48.0-70.0); Control: 56.5 (32-72)	TCC: 14M16F; WTK: 12M18F; Control: 7M23F	TCC: 2.0yr experience; WTK: 2.3 yr experience; Control: 0 yr	WTK	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	Kruskal-Wallis one-way analysis of variance on ranks was utilized. Comparing 30 and 60 min afterWTK and TCC :The mean RRI (RR intevals) (WTK 30 min: 0; 60 min:6; TCC 30min:3; 60 min:6; $p<0.05$), SDRR (Standard deviation of RR) (WTK -4%: 0; 60 min:2%; TCC 30min:0%; 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 VLFP (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
Lu WA *et al.,* 2003 [119]	QED	40	Taiwan	WTK: 58. 1 ± 5.9, CON: 55.9 ± 8.3	14M26F	WTK: 5.6 ± 6.0 yrs, CON: 0	WTK	20 in WTK, 20 in control goup	To evaluate the effect of WTK on autonomic nervous modulation in the elderly	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 tes. We found that the standard 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 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.

[1]TC=total cholesterol, TG= triglyceride LDL-C=low-density lipoprotein cholesterol, HDL-C=high-density lipoprotein cholesterol
[2]TC=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
[3]TBIL= total bilirubin,DBIL=direct bilirubin, IBIL=indirect bilirubin

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 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 juxtapose 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 devises, 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 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 believes 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.

References

1. Liu X, Miller Y, Burton N, Brown W (2010) A preliminary study of the effects of Tai Chi and Qigong medical exercise on indicators of metabolic syndrome, glycaemic control, health-related quality of life, and psychological health in adults with elevated blood glucose. *Br J Sports Med* 44: 704-709. [Crossref]

2. Lu Z (1997) Scientific Qigong exploration: The Wonders and Mysteries of Qi. Amber Leaf Press, Malvern, PA.

3. Cohen K (1999) The way of Qigong: The art and science of Chinese energy healing. Ballantine Books, New York.

4. Oh B, Butow P, Mullan B, Hale A, Lee MS, et al. (2012) A critical review of the effects of medical Qigong on quality of life, immune function, and survival in cancer patients. *Integr Cancer Ther* 11: 101-110. [Crossref]

5. Chan CL, Wang CW, Ho RT, Ng SM, Chan JS, et al. (2012) A systematic review of the effectiveness of qigong exercise in supportive cancer care. *Support Care Cancer* 20: 1121-1133. [Crossref]

6. Klein PJ, Schneider R, Rhoads CJ3 (2016) Qigong in cancer care: a systematic review and construct analysis of effective Qigong therapy. *Support Care Cancer*. [Crossref]

7. Tao WW, Jiang H, Tao XM, Jiang P, Sha LY, et al. (2016) Effects of Acupuncture, Tuina, Tai Chi, Qigong, and Traditional Chinese Medicine Five-Element Music Therapy on Symptom Management and Quality of Life for Cancer Patients: A Meta-Analysis. *J Pain Symptom Manage* 51: 728-747. [Crossref]

8. Ng B, Tsang H, Ng B, So C (2014) Traditional Chinese exercises for pulmorary rehabilitation: Evidence from a systematic review. *Journal of Cardiopulmonary Regabilitation and Prevention* 34: 367-377. [Crossref]

9. Chan CL, Wang CW, Ho RT, Ho AH, Ziea ET, et al. (2012) A systematic review of the effectiveness of qigong exercise in cardiac rehabilitation. *Am J Chin Med* 40: 255-267. [Crossref]

10. Lee MS, Pittler MH, Guo R, Ernst E (2007) Qigong for hypertension: a systematic review of randomized clinical trials. *J Hypertens* 25: 1525-1532. [Crossref]

11. Xiong X, Wang P, Li X, Zhang Y (2015) Qigong for hypertension: a systematic review. *Medicine (Baltimore)* 94: e352. [Crossref]

12. Guo X, Zhou B, Nishimura T, Teramukai S, Fukushima M (2008) Clinical effect of qigong practice on essential hypertension: a meta-analysis of randomized controlled trials. *J Altern Complement Med* 14: 27-37. [Crossref]

13. Wang CW, Ng SM, Ho RT, Ziea ET, Wong VC, et al. (2012) The effect of qigong exercise on immunity and infections: a systematic review of controlled trials. *Am J Chin Med* 40: 1143-1156. [Crossref]

14. Lee MS, Ernst E (2009) Qigong for movement disorders: A systematic review. *Mov Disord* 24: 301-303. [Crossref]

15. Yang Y, Qiu WQ, Hao YL, Lv ZY, Jiao SJ, et al. (2015) The efficacy of traditional Chinese Medical Exercise for Parkinson's disease: a systematic review and meta-analysis. *PLoS One* 10: e0122469. [Crossref]

16. Chan CL, Wang CW, Ho RT, Ng SM, Ziea ET, et al. (2012) Qigong exercise for the treatment of fibromyalgia: a systematic review of randomized controlled trials. *J Altern Complement Med* 18: 641-646. [Crossref]

17. Lee MS, Chen KW, Choi TY, Ernst E (2009) Qigong for type 2 diabetes care: a systematic review. *Complement Ther Med* 17: 236-242. [Crossref]

18. Lee MS, Pittler MH, Ernst E (2009) Internal qigong for pain conditions: a systematic review. *J Pain* 10: 1121-1127. [Crossref]

19. Oh B, Choi SM, Inamori A, Rosenthal D, Yeung A (2013) Effects of qigong on depression: a systemic review. *Evid Based Complement Alternat Med* 2013: 134737. [Crossref]

20. Wang CW, Chan CH, Ho RT, Chan JS, Ng SM, et al. (2014) Managing stress and anxiety through qigong exercise in healthy adults: a systematic review and meta-analysis of randomized controlled trials. *BMC Complement Altern Med* 14: 8. [Crossref]

21. Chen KW (2004) An analytic review of studies on measuring effects of external QI in China. Altern *Ther Health Med* 10: 38-50. [Crossref]

22. Lin Z, Chen K (2002) Exploratory studies of external Qi in China. *Journal of International Society of Life Information Sciences* 20: 457-461.

23. Chen KW (2004) An analytic review of studies on measuring effects of external QI in China. *Altern Ther Health Med* 10: 38-50. [Crossref]

24. Hintz KJ, Yount GL, Kadar I, Schwartz G, Hammerschlag R, et al. (2003) Bioenergy definitions and research guidelines. *Altern Ther Health Med* 9: A13-30. [Crossref]

25. Mayer M (1999) Qigong and hypertension: a critique of research. *J Altern Complement Med* 5: 371-382. [Crossref]

26. Chen K (2015) Methodological challenges and research design in research study of qigong therapies. In: Methodologies for Effective Assessing Complementary and Alternative Medicine (CAM): Research Tools and Techniques: Singing Dragon Pp. 228-248.

27. Lo S (2007) Evidence and mechanism of external Qi in chinese medicine. *Medical Acupuncture* 19: 2001-2009.

28. Matos LC, Sousa CM, GonÃ§alves M, Gabriel J, Machado J, et al. (2015) Qigong as a Traditional Vegetative Biofeedback Therapy: Long-Term Conditioning of Physiological Mind-Body Effects. *Biomed Res Int*: 31789. [Crossref]

29. Litscher G, Wenzel G, Niederwieser G, Schwarz G (2001) Effects of QiGong on brain function. *Neurol Res* 23: 501-505. [Crossref]

30. Matos LC, Sousa CM, GonÃ§alves M, Gabriel J, Machado J, et al. (2015) Qigong as a Traditional Vegetative Biofeedback Therapy: Long-Term Conditioning of Physiological Mind-Body Effects. *Biomed Res Int* 2015: 531789. [Crossref]

31. Zimmerman J (1989) Zimmerman J: Laying-on-of-hands and therapeutic touch: a testable theory, BEMI currents. *J Bio-Electro-Magnet Ins* 1989: 2-8.

32. Seto A, Kusaka C, Nakazato S, Huang WR, Sato T, et al. (1992) Detection of extraordinary large bio-magnetic field strength from human hand during external Qi emission. *Acupunct Electrother Res* 17: 75-94.[Crossref]

33. Hisamitsu T, Seto A, Nakazato S, Yamamoto T, Aung SK (1996) Emission of extremely strong magnetic fields from the head and whole body during oriental breathing exercises. *Acupunct Electrother Res* 21: 219-227. [Crossref]

34. Yu WL, Li XQ, Tang WJ, Li Y, Weng XC, et al. (2007) fMRI study of pain reaction in the brain under state of "Qigong". *Am J Chin Med* 35: 937-945. [Crossref]

35. Chan AS, Cheung MC, Chan YL, Yeung DK, Lam W (2006) Bilateral frontal activation associated with cutaneous stimulation of elixir field: an FMRI study. *Am J Chin Med* 34: 207-216. [Crossref]

36. Litscher G, Wenzel G, Niederwieser G, Schwarz G (2001) Effects of QiGong on brain function. *Neurol Res* 23: 501-505. [Crossref]

37. Faber PL, Lehmann D, Tei S, Tsujiuchi T, Kumano H, et al. (2012) EEG source imaging during two Qigong meditations. *Cogn Process* 13: 255-265. [Crossref]

38. Qin Z, Jin Y, Lin S, Hermanowicz NS (2009) A forty-five year follow-up EEG study of Qigong practice. *Int J Neurosci* 119: 538-552. [Crossref]

39. Baldwin AL, Hammerschlag R2 (2014) Biofield-based therapies: a systematic review of physiological effects on practitioners during healing. *Explore (NY)* 10: 150-161. [Crossref]

40. Zhang W, Zheng R, Zhang B, Yu W, Shen X (1993) An observation on flash evoked cortical potentials and Qigong meditation. *Am J Chin Med* 21: 243-249. [Crossref]

41. Liu GL, Cui RQ, Li GZ, Huang CM (1990) Changes in brainstem and cortical auditory potentials during Qi-Gong meditation. *Am J Chin Med* 18: 95-103. [Crossref]

42. Kuan SC, Chen KM, Wang C (2012) Effectiveness of Qigong in promoting the health of wheelchair-bound older adults in long-term care facilities. *Biol Res Nurs* 14: 139-146. [Crossref]

43. Lu WA, Kuo CD (2003) The effect of Tai Chi Chuan on the autonomic nervous modulation in older persons. *Med Sci Sports Exerc* 35: 1972-1976. [Crossref]

44. Chang MY (2015) Qigong Effects on Heart Rate Variability and Peripheral Vasomotor Responses. *West J Nurs Res* 37: 1383-1403. [Crossref]

45. Jones BM (2001) Changes in cytokine production in healthy subjects practicing Guolin Qigong : a pilot study. *BMC Complement Altern Med* 1: 8. [Crossref]

46. Lee MS, Kim BG, Huh HJ, Ryu H, Lee HS, et al. (2000) Effect of Qi-training on blood pressure, heart rate and respiration rate. *Clin Physiol* 20: 173-176. [Crossref]

47. Lee MS, Rim YH, Kang CW (2004) Effects of external qi-therapy on emotions, electroencephalograms, and plasma cortisol. *Int J Neurosci* 114: 1493-1502. [Crossref]

48. Yeh ML, Lee TI, Chen HH, Chao TY (2006) The influences of Chan-Chuang qi-gong therapy on complete blood cell counts in breast cancer patients treated with chemotherapy. *Cancer Nurs* 29: 149-155. [Crossref]

49. Lin H (2013) Effects of Wuqinxi on senior patients with hypertension. *Chinese Journal of Geriatrics* 2013: 33.

50. Li C (2013) Effect of health qigong and new skills on the middle and old aged people's blood lipid. *Journal of Chengdu Sport University*: 39.

51. Chen, Chen (2015) Effect of Taichi and Qigong on blood lipid and life quality of middle aged and elderly people. *Chinese Journal of Geriatrics*: 35.

52. Liu X, Miller YD, Burton NW, Brown WJ (2010) A preliminary study of the effects of Tai Chi and Qigong medical exercise on indicators of metabolic syndrome, glycaemic control, health-related quality of life, and psychological health in adults with elevated blood glucose. *Br J Sports Med* 44: 704-709. [Crossref]

53. Sun GC, Lovejoy JC, Gillham S, Putiri A, Sasagawa M, et al. (2010) Effects of Qigong on glucose control in type 2 diabetes: a randomized controlled pilot study. *Diabetes Care* 33: e8. [Crossref]

54. Manzaneque JM, Vera FM, Rodriguez FM, Garcia GJ, Leyva L, et al. (2009) Serum cytokines, mood and sleep after a qigong program: is qigong an effective psychobiological tool? *J Health Psychol* 14: 60-67. [Crossref]

55. Ryu H, Lee HS, Shin YS, Chung SM, Lee MS, et al. (1996) Acute effect of qigong training on stress hormonal levels in man. *Am J Chin Med* 24: 193-198. [Crossref]

56. Weidermann M, Smith J, Gray A, Pyne D, Braddon M, et al. (1994) Exercise and neutrophil activity: A possible neuroendocrine connection. In: PsychoimmunologyL CNS- Immune Interactions: CRS Press. Pp. 31-50.

57. Lee MS, Kim MK, Ryu H (2005) Qi-training (qigong) enhanced immune functions: what is the underlying mechanism? *Int J Neurosci* 115: 1099-1104. [Crossref]

58. Ryu H, Lee MS, Jeong SM, Lee JH, Kang CW, et al. (2000) Modulation of neuroendocrinological function by psychosomatic training: acute effect of ChunDoSunBup Qi-training on growth hormone, insulin-like growth factor (IGF)-I, and insulin-like growth factor binding protein (IGFBP)-3 in men. *Psychoneuroendocrinology* 25: 439-451.

59. Lee MS, Huh HJ, Jeong SM, Lee HS, Ryu H, et al. (2003) Effects of Qigong on immune cells. *Am J Chin Med* 31: 327-335. [Crossref]

60. Manzaneque JM, Vera FM, Maldonado EF, Carranque G, Cubero VM, et al. (2004) Assessment of immunological parameters following a qigong training program. *Med Sci Monit* 10: CR264-270. [Crossref]

61. Yang Y, Verkuilen J, Rosengren KS, Mariani RA, Reed M, et al. (2007) Effects of a Taiji and Qigong intervention on the antibody response to influenza vaccine in older adults. *Am J Chin Med* 35: 597-607. [Crossref]

62. Liu X, Miller YD, Burton NW, Brown WJ (2010) A preliminary study of the effects of Tai Chi and Qigong medical exercise on indicators of metabolic syndrome, glycaemic control, health-related quality of life, and psychological health in adults with elevated blood glucose. *Br J Sports Med* 44: 704-709. [Crossref]

63. Mao S, Zhang X, Shao B, Hu X, Hu Y, et al. Baduanjin Exercise Prevents post-Myocardial Infarction Left Ventricular Remodeling (BE-PREMIER trial): Design and Rationale of a Pragmatic Randomized Controlled Trial. *Cardiovasc Drugs Ther*

64. Muehsam D, Chevalier G, Barsotti T, Gurfein BT4 (2015) An Overview of Biofield Devices. Glob *Adv Health Med* 4: 42-51. [Crossref]

65. Oschman J (2000) Energy Medicine: The Scientific Basis: Elsevier, USA.

66. Ross S, Walker A, MacLeod MJ (2004) Patient compliance in hypertension: role of illness perceptions and treatment beliefs. *J Hum Hypertens* 18: 607-613. [Crossref]

67. Jouper J, HassmÃ©n P (2009) Exercise intention, age and stress predict increased qigong exercise adherence. *J Bodyw Mov Ther* 13: 205-211. [Crossref]

68. Dong X, Bergren SM, Chang ES (2015) Traditional Chinese Medicine Use and Health in Community-Dwelling Chinese-American Older Adults in Chicago. *J Am Geriatr Soc* 63: 2588-2595. [Crossref]

69. Willison KD, Andrews GJ (2004) Complementary medicine and older people: past research and future directions. *Complement Ther Nurs Midwifery* 10: 80-91. [Crossref]

70. Eisenhardt S, Fleckenstein J (2016) Traditional Chinese medicine valuably augments therapeutic options in the treatment of climacteric syndrome. *Arch Gynecol Obstet*. [Crossref]

71. Yan X, Shen H, Loh C, Shao J, Yang Y, et al. (2013) A longitudinal study about the effect of practicing Yan Xin Qigong on medical care cost with medical claims data. *Int J Econ Res* 10: 391-403.[Crossref]

72. Belza B, Walwick J, Shiu-Thornton S, Schwartz S, Taylor M, et al. (2004) Older adult perspectives on physical activity and exercise: voices from multiple cultures. *Prev Chronic Dis* 1: A09. [Crossref]

73. Shin H, Kim J, Soh K (2003) Investigation of Anomalous Bio-Magnetic Fields from Human Hand During Qi Emission. *Journal of International Society of Life Information Science* 21: 42-49.

74. Ho FM, Ding HY, Chyau CC, Kuo HY, Yen MT, et al. (2011) To accomplish preliminary Qigong simulation state by acupuncture. *Zhong Xi Yi Jie He Xue Bao* 9: 1094-1100. [Crossref]

75. Fong D, Hung T, Huang Y (2004) The effects of qigong on relaxation and emotion. *Taiwan Sports Psychology* 5: 19-42.

76. Lee MS, Bae BH, Ryu H, Sohn JH, Kim SY, et al. (1997) Changes in alpha wave and state anxiety during ChunDoSunBup Qi-training in trainees with open eyes. *Am J Chin Med* 25: 289-299. [Crossref]

77. Kuo T, Ho F, Lin C (2003) Physiological changes associated with Neiyang Qigong. *Journal of Health Sciences* 49: 278-284.

78. Wirth DP, Cram JR, Chang RJ (1997) Multisite electromyographic analysis of therapeutic touch and qigong therapy. *J Altern Complement Med* 3: 109-118. [Crossref]

79. Chang MY (2015) Qigong Effects on Heart Rate Variability and Peripheral Vasomotor Responses. *West J Nurs Res* 37: 1383-1403. [Crossref]

80. Zhang (2006) Research and health care qigong on Cardiac and cerebral vessal of middle and elder people. *China Sport Science and Technology* 42: 98-101.

81. Lee MS, Kim MK, Lee YH (2005) Effects of Qi-therapy (external Qigong) on cardiac autonomic tone: a randomized placebo controlled study. *Int J Neurosci* 115: 1345-1350. [Crossref]

82. Lim YA, Boone T, Flarity JR, Thompson WR (1993) Effects of qigong on cardiorespiratory changes: a preliminary study. *Am J Chin Med* 21: 1-6. [Crossref]

83. Sun FL, Yan YA (1992) [Effects of various qigong breathing pattern on variability of heart rate]. *Zhongguo Zhong Xi Yi Jie He Za Zhi* 12: 527-530, 516.[Crossref]

84. Lan C, Chou SW, Chen SY, Lai JS, Wong MK (2004) The aerobic capacity and ventilatory efficiency during exercise in Qigong and Tai Chi Chuan practitioners. *Am J Chin Med* 32: 141-150. [Crossref]

85. Zeng (2013) Effect of Relaxation Qigong on hypertension of the elderly patients. *Chinese Journal of Social Medicine* 2013: 30.

86. Huang L (2013) Effects of Wuqinxi on senior patients with hypertension. *Chinese Journal of Geriatrics* 2013: 33.

87. Lee M, Choi E, Chung H (2003) Effects of Qigong on blood pressure, blood pressure determinants and ventilatory function in middle-aged patients with essential hypertension. *Am J Chin Med* 31: 489-497. [Crossref]

88. Cheung BM, Lo JL, Fong DY, Chan MY, Wong SH, et al. (2005) Randomised controlled trial of qigong in the treatment of mild essential hypertension. *J Hum Hypertens* 19: 697-704. [Crossref]

89. Lee MS, Lim HJ, Lee MS (2004) Impact of qigong exercise on self-efficacy and other cognitive perceptual variables in patients with essential hypertension. *J Altern Complement Med* 10: 675-680. [Crossref]

90. Sun (2008) Influence of fitness Qigong (Baduanjin) on blood lipid and physioloigcal function of the elder male people. *China Sport Science and Technology* 44: 81-84.

91. Lee MS, Lee MS, Kim HJ, Choi ES (2004) Effects of qigong on blood pressure, high-density lipoprotein cholesterol and other lipid levels in essential hypertension patients. *Int J Neurosci* 114: 777-786. [Crossref]

92. Vera FM, Manzaneque JM, Maldonado EF, Carranque GA, Cubero VM, et al. (2007) Biochemical changes after a qigong program: lipids, serum enzymes, urea, and creatinine in healthy subjects. *Med Sci Monit* 13: CR560-566. [Crossref]

93. Miao F, Liu X, Wang X (2009) Effects of fitness qigong baduanjin on plasma lipid and lipoprotein metabolism of patients with hyperlipidemia. *Journal of Shandong Institute of Physical Education and Sports* 2009.

94. Liang (2014) Effect of Baduanjin on blood pressure and blood lipid of patients with essential hypertension. *Henan Traditional Chinese Medicine* 2014: 34.

95. Jin L (2010) Effect of fitness Qigong (Yijinjing) on blood lipid and free radical metabolism of the elder women. *China Journal of Traditional Chinese Medicine and Pharmacy* 2010: 25.

96. Youngwanichsetha S, Phumdoung S, Ingkathawornwong T (2013) The effects of tai chi qigong exercise on plasma glucose levels and health status of postpartum Thai women with type 2 diabetes. *Focus on Alrernative and Complementary Therapies* 2013;18:182-7.

97. Iwao M, Kajiyama S, Mori H, Oogaki K (1999) Effects of qigong walking on diabetic patients: a pilot study. *J Altern Complement Med* 5: 353-358. [Crossref]

98. Tao Y (2015) Effects of BaDuanJin exercise on Bilirubin in type 2 diabetes patients. *Guiding Journal of Traditional Chinese Medicine and Pharmacy* 2015: 21.

99. Oh B, Butow P, Mullan B, Clarke S, Beale P, et al. (2010) Impact of medical Qigong on quality of life, fatigue, mood and inflammation in cancer patients: a randomized controlled trial. *Ann Oncol* 21: 608-614. [Crossref]

100. Oh B, Butow P, Mullan B, Clarke S (2008) Medical Qigong for cancer patients: pilot study of impact on quality of life, side effects of treatment and inflammation. *Am J Chin Med* 36: 459-472. [Crossref]

101. Chan ES, Koh D, Teo YC, Hj Tamin R, Lim A, et al. (2013) Biochemical and psychometric evaluation of Self-Healing Qigong as a stress reduction tool among first year nursing and midwifery students. *Complement Ther Clin Pract* 19: 179-183. [Crossref]

102. Sousa CM, Goncalves M, Machado J, Efferth T, Greten T, et al. (2012) Effects of qigong on performance-related anxiety and physiological stress functions in transverse flute music schoolchildren: a feasibility study. *Zhong Xi Yi Jie He Xue Bao* 10: 858-68.

103. Chow Y, Siu A (2012) The effects of qigong on reducing stress and anxiety and enhacing body-mind well-being. *Mindfulness* 3: 51-59.

104. Bayat-Movahed S, Shayesteh Y, Mehrizi H, Rezayi S, Bamdad K, et al. (2008) Effects of Qigong exercises on 3 different parameters of human saliva. *Chin J Integr Med* 14: 262-266. [Crossref]

105. Wu Y (2008) Effects of exercising building up Qigong Quqinxi on middle aged and old peopls' NK cell activity. *Journal of Shanghai University of Sport* 2008: 32.

106. Vera FM, Manzaneque JM, Rodriguez FM, Bendayan R, Fernandez N, et al. (2015) Acute effects on the counts of innate and adaptive immune response cells after 1 month of taoist qigong practice. *Int J Behav Med* 23: 198-203. [Crossref]

107. Lee M, Kang CW, Ryu H (2005) Acute effect of qi-training on natural killer cell subsets and cytotoxic activity. *Int J Neurosci* 115: 285-297. [Crossref]

108. Jung MJ, Shin BC, Kim YS, Shin YI, Lee MS (2006) Is there any difference in the effects of Qi therapy (external Qigong) with and without touching? A pilot study. *Int J Neurosci* 116: 1055-1064. [Crossref]

109. Lee MS, Kang CW, Ryu H, Kim JD, Chung HT (1999) Effects of ChunDoSunBup Qi-training on growth hormone, insulin-like growth factor-I, and testosterone in young and elderly subjects. *Am J Chin Med* 27: 167-175. [Crossref]

110. Ryu H, Jun CD, Lee BS, Choi BM, Kim HM, et al. (1995) Effect of qigong training on proportions of T lymphocyte subsets in human peripheral blood. *Am J Chin Med* 23: 27-36. [Crossref]

111. Yao BS (1989) [A preliminary study on the changes of T-cell subsets in patients with aplastic anemia treated with qigong]. *Zhong Xi Yi Jie He Za Zhi* 9: 341-3, 324. [Crossref]

112. Ryu H, Mo H, Mo G (1995) Delayed cutaneous hypersensitivity reactions in Qigong (Chun Do Sun Bup) trainees by multisite cell mediated immunity. *American Journal of Chinese Medicine* 2: 139-144.

113. Sang Q (2011) Effect of "wuqinxi" exercise on antioxidant status, intestine Bacillus acidophilus, lactobacillus casei and Bacillus bifidus in obese old people. *Journal of Medicinal Plants Research* 5: 4225-4447.

114. Kim E, Woon J (2013) Impact of Qi-gong for mental and physical training on the body composition and aging-related hormone of middle-aged women. *Exercise Science* 22: 239-247.

115. Lee MS, Kang CW, Ryu H, Moon SR (2004) Endocrine and immune effects of Qi-training. *Int J Neurosci* 114: 529-537. [Crossref]

116. Lee MS, Jeong SM, Kim YK, Park KW, Lee MS, et al. Qi-training enhances respiratory burst function and adhesive capacity of neutrophis in young adults: A preliminary study. *Am J Chin Med* 31: 141-148. [Crossref]

117. Chang H (2005) Influence of body building qigong and eight-sectioned brocade on the metabolism of nitric oxide, malondialdehyde and superoxide dismutase in middle-aged and elderly people of different gender. *Chinese Journal of Clinical Rehabilitation* 9.

118. Lu WA, Kuo CD (2006) Comparison of the effects of Tai Chi Chuan and Wai Tan Kung exercises on autonomic nervous system modulation and on hemodynamics in elder adults. *Am J Chin Med* 34: 959-968. [Crossref]

119. Lu WA, Kuo CD (2003) The effect of wai tan kung on autonomic nervous modulation in the elderly. *J Biomed Sci* 10: 697-705. [Crossref]