Effects of Guang-Im-Ju-Jai-Gong Qigong on Endothelial Function, Cardio-Ankle Vascular Index (CAVI), Ankle Brachial Index (ABI) in Female Adults with Metabolic Syndrome

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ABSTRACT

Thongthawee B, Sangwatanaroj S, Sanguanrungsirikul S. Effects of Guang-Im-Ju-Jai-Gong Qigong on Endothelial Function, Cardio-Ankle Vascular Index (CAVI), Ankle Brachial Index (ABI) in Female Adults with Metabolic Syndrome. JEPonline 2016;19(1):39-49. The purpose of this study was to determine the effects of the Guang-Im-Ju-Jai-Gong Qigong (GQ) on forearm blood flow (FBF), Cardio-Ankle Vascular Index (CAVI), and Ankle Brachial Index (ABI) in sedentary female adults with metabolic syndrome (MetS) after a 12-wk training program. Fifty-five females (aged 40 to 65 yrs) with MetS were randomly allocated to the Control Group (CG, n = 27) and GQ Group (GQ, n = 28). The GQ Group performed Guang-Im-Ju-Jai-Gong Qigong 1 hr·d⁻¹, 4 times·wk⁻¹ for 12 wks. The CG received health education and usual activity. The data showed an increase in FBF (P<0.05) and VO₂ peak (P<0.05), a decrease in systolic blood pressure (P<0.05) and waist circumference (P<0.05) with no changes in CAVI and ABI. The findings indicate that GQ is an alternative type of exercise that can reduce the risk of vascular disease in female adults. As such, it should be used as a health promotion strategy for adults with MetS.

Key Words: Guang-Im-Ju-Jai-Gong Qigong, Endothelial function, Cardio-Ankle Vascular Index, Ankle Brachial Index
INTRODUCTION

Metabolic syndrome (MetS) is a group of clinical metabolic disorders that includes obesity, insulin resistance, glucose intolerance, hypertension, and dyslipidemia. As a result of these disorders, MetS appears to promote the development of atherosclerosis and vascular disease (14). This is a major problem since 20 to 25% of the adult population worldwide has MetS (2), which is in agreement with the 23.2% in Thailand adults (19.5% in men and 26.8% in women). To eliminate this health problem, Thailand continues to address the risk factors at a high socioeconomic cost (22).

The progression of MetS leads to the vascular endothelial dysfunction, which normally controls the vascular property. The endothelial dysfunction is the culprit in the development of atherosclerosis, vascular disease, and diabetes. Thus, individuals who have risk factors for MetS are encouraged to modify their lifestyle behaviors or receive medical treatment to reduce the risk associated with hyperglycemia, dyslipidemia, and hypertension (9,18). Endothelial cell assessment is essential in the prevention and management of risk factors (18). Venous occlusion plethysmography (VOP) is a non-invasive measurement used to assess endothelial function (10,11,24). The area under the curve (AUC) of forearm blood flow (FBF) from VOP represents the functional response of the endothelial cell (5). Moreover, there is a clinical assessment of vascular structure called Cardio-Ankle Vascular Index (CAVI) (25,27) to detect vascular elasticity and Ankle Brachial Index (ABI) to reflect vascular stenosis (1,4).

Qigong is a Traditional Chinese Medicine (TCM) that is practiced worldwide (28). While there are many types of Qigong such as Frangrant Qigong (26) and Walking Qigong (Guolin Qigong) (17), the oldest style of Qigong is called Eight Stand of Brocade Qigong (Ba Duan Jin) (32). It has been shown that Qigong can prevent and reduce the risk factors for chronic diseases. Previously, a study in cancer patients found that Eight Stand of Brocade Qigong had an inhibiting effect on cancer growth (7). It has also been demonstrated that Qigong can reduce stress, depression, and anxiety, thus improving the quality of life (13,30). Qigong has also been demonstrated to be useful in decreasing blood pressure in mild essential hypertension, and in reducing blood sugar, HbA1C, and blood viscosity in type 2 diabetes mellitus (8,20). The decrease in these parameters can help correct or diminish the severity and/or complications resulting from cardiovascular disease.

As to Guang-Im-Ju-Jai-Gong Qigong, it was developed by the Qigong Master Yang. This particular type of Qigong is recommended by the Department of Thai Traditional and Complementary Medicine, the Ministry of Public Health in Thailand as the complementary and alternative medicine. It is believed to be safe, and it appears to result in positive and beneficial effects in both healthy and unhealthy adults. However, from a research perspective, there are no studies that have reported scientific findings regarding the assumed positive health effects of Guang-Im-Ju-Jai-Gong Qigong on endothelial function and vascular structure in sedentary female adults with MetS.

Accordingly, the purpose of this study was to demonstrate the positive effects, if any, on endothelial function and vascular structure in sedentary female adults with MetS following 12 wks of training in Guang-Im-Ju-Jai-Gong Qigong.
METHODS

Subjects
A total of 55 sedentary female adults with MetS (aged 40 to 65 yrs) were studied in Bangkok, Thailand. The inclusion criteria included adults with MetS, defined according the National Cholesterol Education Program, Adult Treatment Panel III (NCEP ATPIII) (14), who met at least three of the following five criteria for women: (a) obesity (waist, >88 cm); (b) low high-density lipoprotein (HDL) cholesterol (<50 mg·dl⁻¹); (c) hypertriglyceridemia (≥150 mg·dl⁻¹); (d) elevated glucose (<126 mg·dl⁻¹); and (e) elevated blood pressure (≥130/85 mmHg or use of hypertensive drugs). The subjects were free from cardiovascular disease (CVD) and diabetes. Exclusion criteria included type 2 diabetes mellitus (T2DM) (HbA₁c ≥6.5% or used diabetic medication), pulmonary disease, atrial fibrillation, valvular heart disease, anemia, angina pectoris, myocardial infarction, ischemic heart disease, or coronary revascularization, which were assessed by a detailed medical history, physical examination, and a resting electrocardiogram. Subjects who regularly exercise for 30 min·d⁻¹, 3 times·wk⁻¹ for more than one month were also excluded. All subjects provided written and informed consent to participate in this study, which was approved by Institutional Review Board, Faculty of Medicine, Chulalongkorn University (COA No.321/2013, IRB No.471/55). The subjects were randomized by block randomization and allocation concealment to the Control Group (n = 27) and the GQ Group (n = 28).

Procedures
Guang-Im-Ju-Jai-Gong Qigong Training Program
GQ training programs consist of three parts: (a) arm swing (backward and forward) 500 repetitions; (b) 18 exercises posture; and (c) three set of finger exercise. It was performed 1 hr·d⁻¹, 4 d·wk⁻¹ for 12 wks in the quiet and ventilate environment without air condition. During those trainings, the participants were paid attention to inspiration and expiration of breathing, relaxation, and concerning the body alignment of standing position. Between each parts of training, the participants performed energy storage postures in Duntain site (2 finger base lower the umbilical) by male put the right hand on the left hand and female put the left hand on the left hand, then, turned both hand 36 rounds clockwise and 36 round counter-clockwise respectively.

Measurements
Endothelial Function
Assessments were performed between 7:00 and 10:00 am in a quiet and temperature-controlled room after a 12-hr fast. The subjects were told to refrain from alcohol, caffeine, vitamins, and exercise for 24 hrs prior to the study getting underway. On completion of the anthropometric assessments and after a minimum 15 min of quiet supine rest, the subjects underwent supine measures of endothelial function. Reactive hyperemia with mercury strain gauge plethysmography and FBF were used to analyze the endothelium. The subjects’ FBF were measured using a mercury-filled Silastic strain-gauge plethysmography (EC-5R; D.E. Hokanson, Inc., Bellevue, WA, USA), as previously described (3). All subjects were allowed to rest in a supine position for 15 min. Subsequently, FBF was measured non-invasively in the non-dominant arm. After the non-dominant upper arm arterial occlusion, a measurement was obtained at the rest period and 5 min later. Prior to obtaining the measurements, two pressure cuffs were placed above the elbow and on the wrist with the forearm elevated, extended, and supinated on a Styrofoam block slightly above the heart. Additionally, the
strain gauge was passed around the forearm approximately 10 cm distal to the olecranon process. The FBF output signal was transmitted to the recorder and the data were expressed as ml·100 ml⁻¹ of forearm tissue volume.

**CAVI and ABI**
The subjects’ CAVI and ABI were measured to detect arterial stiffness and stenosis. Before testing, they were advised to refrain from caffeine, alcohol consumption, and heavy activity. A quiet and warm environment (21 to 23 ± 1º C) was used to perform the test in order to prevent arterial vasoconstriction. In addition, the subjects were asked to remove socks, shoes, and tight clothing to place the pressure cuffs and to provide access to the pulse sites by Doppler. The subjects were asked to assume a flat, supine position. Then, the pressure cuffs were place with the bottom of the cuff approximately 2 to 3 cm above the cubital fossa on the arm and malleolus at the ankle. The ECG electrodes were placed on both wrists, and a microphone for detecting heart sounds was placed on the sternum. In order to normalize heart rate and blood pressure, the subjects were asked to assume comfortable position for least 5 min of rest prior the test. After the measurements were determined and data were analyzed by software, and the values for the right CAVI and the right ABI were obtained for analysis using a VaserVS-1000 vascular screening system (27), the subjects’ resting heart rate and supine resting blood pressure were determined.

Body anthropometry including the subjects’ height, body weight, waist circumference (WC), and BMI were measured using standard laboratory procedures. Standing height was measured to the nearest 0.1 cm with the use of a wall-mounted stadiometer. Body weight was measured with the use of a weight scale (Yamato DP-6100GP Japan) and BMI was calculated by dividing weight (kg) by height (m²). The subjects’ WC was measured at the superior border of the iliac crest to the nearest 0.1 cm after a normal expiration.

Each subject’s VO₂ peak was measured during the incremental exercise test using a standard oxygen and carbon dioxide gas analyzer (Oxycon, USA). Oxygen consumption (VO₂), carbon dioxide production (VCO₂), minute ventilation (Vₑ), and other derived parameter were continuously monitored breath-by-breath via the metabolic analyzer (Oxycon, USA). The data were expressed in a standard condition of standard temperature pressure dry (STPD). The Naughton’s protocol for treadmill exercise was used during the exercise test. The subjects’ VO₂ peak criteria were defined as follows: (a) the highest value of VO₂ attained during the treadmill test; (b) cannot continue the test; (c) chest pain; and/or (d) evidence of an abnormal cardiopulmonary response (such cyanosis, fainting, and loss of consciousness) (21).

**Statistical Analyses**
All the data were checked for normality, then, checked for normal distribution if it was found to be violated. An alpha level of P<0.05 was considered a statistically significant difference. The data were expressed as mean ± standard deviation. The independent-sample t-test was used to identify difference between Groups. The paired-sample t-test was used to identify within group difference.
RESULTS

The subjects’ baseline characteristics for age, BMI, WC, blood pressure, FPG, triglyceride, and HDL-C for both Groups were not significantly different from each other (Table 1).

Table 1. Subjects Characteristics.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Control Group (n = 27)</th>
<th>GQ Group (n = 28)</th>
</tr>
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<tbody>
<tr>
<td>Age (yrs)</td>
<td>52.56 ± 2.56</td>
<td>51 ± 2.56</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>154.77 ± 5.72</td>
<td>156.92 ± 6.17</td>
</tr>
<tr>
<td>BW (kg)</td>
<td>62.58 ± 11.72</td>
<td>62.49 ± 11.15</td>
</tr>
<tr>
<td>BMI (kg·m⁻²)</td>
<td>26.24 ± 5.55</td>
<td>25.96 ± 4.17</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>88.18 ± 8.51</td>
<td>89.17 ± 10.43</td>
</tr>
<tr>
<td>SBP (mmHg)</td>
<td>134.26 ± 10.30</td>
<td>134.89 ± 15.73</td>
</tr>
<tr>
<td>DBP (mmHg)</td>
<td>81.04 ± 18.06</td>
<td>79.04 ± 10.19</td>
</tr>
<tr>
<td>FPG (mg%)</td>
<td>86.57 ± 14.08</td>
<td>89.96 ± 13.89</td>
</tr>
<tr>
<td>Triglyceride (mg%)</td>
<td>173.96 ± 28.46</td>
<td>173.89 ± 41.62</td>
</tr>
<tr>
<td>HDL-C (mg%)</td>
<td>47.64 ± 5.19</td>
<td>46.14 ± 8.48</td>
</tr>
</tbody>
</table>

Data expressed as mean ± SD; BW, Body Weight; BMI, Body Mass Index; WC, Waist Circumference; SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure; FPG, Fasting Plasma Glucose; HDL-C, High Density Lipoprotein Cholesterol

After 12 wks of the Qigong training program, the subjects’ WC was significantly decreased (89.17 ± 10.43 to 86.71 ± 10.96 cm, P<0.05). But, when compared to the Control Group post mean measurement, there was no significance difference in WC. No significant changes were observed for BMI in both Groups. Although the Pre (23.58 ± 4.56) to Post (26.11 ± 3.48 ml·kg⁻¹·min⁻¹) VO₂ peak was slightly increased in the GQ Group, it was nonetheless statistically significant (P<0.05). Post supine SBP was significantly decreased (P<0.05) in the GQ Group versus the Pre supine SBP value. Also, the Post supine SBP of the GQ Group was significantly different from the Post supine SBP of the Control Group (P<0.05). For DBP (79.04 ± 10.19 vs. 77.89 ± 11.19), resting heart rate (67.21 ± 8.01 vs. 66.68 ± 9.20), and BMI (25.94 ± 4.17 vs. 25.51 ± 4.08), there were no significant differences in both Groups (Table 2).

Table 2. Changes in Anthropometric and Fitness After 12 Weeks of Qigong Training.

<table>
<thead>
<tr>
<th></th>
<th>Control Group (n = 27)</th>
<th>Qigong Group (n = 28)</th>
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<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>BMI (kg·m⁻²)</td>
<td>26.24 ± 5.54</td>
<td>26.15 ± 5.26</td>
</tr>
<tr>
<td>WC (cm)</td>
<td>88.18 ± 8.51</td>
<td>88.25 ± 8.64</td>
</tr>
<tr>
<td>Resting HR (beats·min⁻¹)</td>
<td>67.78 ± 9.55</td>
<td>68.26 ± 10.15</td>
</tr>
<tr>
<td>Supine SBP (mmHg)</td>
<td>134.26 ± 10.30</td>
<td>132.89 ± 14.04</td>
</tr>
<tr>
<td>Supine DBP (mmHg)</td>
<td>81.04 ± 18.06</td>
<td>80 ± 17.96</td>
</tr>
<tr>
<td>VO₂ Peak (ml·kg⁻¹·min⁻¹)</td>
<td>24.06 ± 6.09</td>
<td>24.38 ± 5.90</td>
</tr>
</tbody>
</table>

Data expressed as mean ± SD; BMI, Body Mass Index; WC, Waist Circumference; VO₂ peak, Peak Oxygen Consumption. *P<0.05 vs. Pre, **P<0.05 vs. Control Group
There were no significant changes in CAVI from Pre to Post, which was also the case with ABI from Pre to Post. Thus, there were no changes in the prediction of vascular stiffness and vascular stenosis, respectively, in both Groups (Table 3).

Table 3. Change in Cardio-Ankle Vascular Index (CAVI) and Ankle Brachial Index (ABI) After 12 Weeks of Qigong Training.

<table>
<thead>
<tr>
<th></th>
<th>Control Group (n = 27)</th>
<th>Qigong Group (n = 28)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Pre</td>
<td>Post</td>
</tr>
<tr>
<td>CAVI</td>
<td>7.73 ± 1.15</td>
<td>7.80 ± 1.05</td>
</tr>
<tr>
<td>ABI</td>
<td>1.06 ± 0.06</td>
<td>1.05 ± 0.10</td>
</tr>
</tbody>
</table>

Data expressed as mean ± SD; CAVI, Cardio-Ankle Vascular Index; ABI, Ankle Brachial Index

Forearm Blood Flow
After 12 wk of Qigong training, the GQ Group demonstrated a significant improvement in FBF from 674.43 to 1092.07 ml·100 ml⁻¹ tissue (P<0.05), and also a significant difference when compared to the control group Post test measurement (P<0.05) (Figure 1).

![Figure 1. Changes in Forearm Blood Flow (FBF) After 12 Weeks of Qigong Training.](image)

Data expressed as mean ± SD; AUC, Area Under the Curve; FBF, Forearm Blood Flow; *P<0.05 vs. Pre, **P<0.05 vs. Control Group

DISCUSSION
The findings of this study indicate that the 12 wks of Guang-Im-Ju-Jai-Gong Qigong resulted in a statistically significant improvement in the function of the endothelium, as represented by the increase in FBF. Also, the subjects’ SBP and WC were decreased after Qigong training.
while the subjects’ functional performance was increased, given the increase in VO₂ peak. However, in regards to statistical difference between the Post VO₂ peak values for both Groups, it is important to point out that the difference is very small (i.e., ~1.53 L·min⁻¹ for the Control Group and ~1.64 L·min⁻¹ for the GQ Group). This difference has no practical value or significance and, therefore, is questionable to speak of the 12 wk of Qigong training as having a positive impact on improving peak cardiorespiratory function.

Although the mechanism remains to be clearly understood, Jerath and colleagues (16) proposed that deep breathing during Qigong training contributes to a physiologic response characterized by a decrease in resting heart rate and resting blood pressure. While the latter physiologic response is in agreement with the present study for Pre to Post in the Qigong Group and the Post findings between both Groups, there were no changes in the subjects’ heart rate in both Groups.

In general, Qigong training consists of 2 components: (a) mind; and (b) body movement. During the mind component of the Qigong training, the subjects were instructed to focus on meditation, imagery, and a breathing technique that is believed to facilitate the energy circulation to the meridians and energy center (13). Previous studies (23,26,31) have reported that Qigong has the effect of relaxing subjects and decreasing their anxiety, which results in a decrease in cortisol and adrenocorticotropic hormone (ACTH) along with an increase in beta-endorphin. The cortisol (a steroid hormone) and ACTH hormone are essential to vasoconstriction (29). On the other hand, the decreased stress hormone could improve vasodilation as shown in the present study by the increase in FBF after 12 wk of Qigong training. In addition, the decrease in SBP and the improvement in vasodilation resulted in the decrease in total peripheral resistance.

In terms of energy flow or Qi flow along meridians, the low resistance fluid channels where various chemical and physical transports take place helps to describe the correlation of meridians with human organ function (33). Kendall (19) also described the meridian stimulation effect on the circulation of the venous system, arterial system, and lymphatic system. Each system is apparently involved in the effects of gas exchange, and vasodilation to increase endothelial function and decrease blood pressure.

Chao and colleagues (6) published their research in 2002 in the American Journal of Chinese Medicine. The purpose of their work was to determine the cardiorespiratory response and energy expenditure during Tai-Chi-Qui-Gong. To do so, they evaluated the cardiorespiratory responses and energy expenditure of 47 Tai-Chi-Qui-Gong subjects (mean age of 60.7 yrs). The researchers reported that Tai-Chi-Qui-Gong has 54 motions that can be divided into 3 sets. Their results indicate that the exercise intensity of each motion was equal to ~3 metabolic equivalents (MET) and the energy expenditure of each set is about 60 kcal. The estimated intensity of Tai-Chi-Qui-Gong in the elderly subjects ~50% of the VO₂ max for the men and ~60% for the women. As an activity that is essentially a low intensity exercise, it is reasonable to recommend Qigong as an alternative exercise program for elderly adults.

Hietanen (15) reported that heavy static exercise is characterized by a failure of the local blood flow to adjust to the oxygen demands of the exercising muscles. Conversely, low intensity exercise triggers aerobic metabolism and stimulate shear stress to endothelial cells, which increases nitric oxide activity that results in vasodilation (12).
CONCLUSIONS

The findings in the present study indicate that when subjects with MetS performed Guang-Im-Ju-Jai-Gong Qigong, there was an improvement in endothelial function, blood pressure, and cardiorespiratory fitness. Hence, even though GQ practiced for 12 wk, 4 d·wk⁻¹, and 1 hr·d⁻¹ is an alternative type of exercise it can reduce the risk of endothelial dysfunction in adults with MetS. Moreover, GQ is a mild body exercise that is easy to practice. It requires no instrument, thus there is a lower cost than most other types of exercise.

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REFERENCES


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