

## Original Articles

# The Effect of Guang-Im-Ju-Jai-Gong Qigong Promoting Program on Ferric Reducing Antioxidant Power (FRAP) Anti-Oxidative Capacity in Metabolic Syndrome

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## Abstract

**Background:** Metabolic syndrome (Mets) is a global health problem which can develop into a chronic disease. Oxidative stress is an important mechanism that activates endothelial dysfunction in Mets and can later progress to crucial pathogenic vascular disease. The increase in anti-oxidative capacity is the mechanism which protects the endothelial cell from reactive oxygen species. Qigong is a type of Traditional Chinese Medicine (TCM) exercise that has previously shown benefits on reducing the risk factor of Mets but no reports on the anti-oxidative capacity has been documented.

**Objective:** To demonstrate the effects of the Guang-Im-Ju-Jai-Gong Qigong (GQ) Promoting Program on Ferric Reducing Antioxidant Power (FRAP) Anti-Oxidative Capacity in metabolic syndrome (Mets) group after the 12-week promoting program.

**Methods:** Fifty-five female metabolic participants aged 40–65 years with metabolic syndrome were randomly allocated to the control ( $n = 27$ ), GQ promoting program ( $n = 28$ ). The GQ promoting program group performed Guang-Im-Ju-Jai-Gong Qigong 1 hour per day, 4 times per week for 12 weeks and the control group received health education and performed usual activities. Plasma Reducing Antioxidant Power (FRAP) Anti-Oxidative Capacity and peak oxygen consumption ( $VO_{2peak}$ ) were measured at baseline and after the program completion. The subject characteristics were expressed as mean  $\pm$  standard deviation. The Independent-Sample T-Test was used to identify the difference of between groups and Paired-Sample T-Test for the within group difference.

**Results:** Within 12 weeks of GQ promoting program, the FRAP level increased significant from baseline,  $41.48 \pm 16.72$  ng/L to  $63.03 \pm 16.71$  ng/L. At the 12 th week of the promoting program, ( $p < 0.05$ ) and increased functional capacity which enhanced  $VO_{2peak}$  from  $23.58 \pm 4.56$  ml/kg/min to  $26.11 \pm 3.48$  ml/kg/min, ( $p < 0.05$ ). Moreover, there was a decrease of the systolic blood pressure from  $134.89 \pm 15.72$  to  $124.82 \pm 15.12$  mmHg at the 12th week promoting program ( $p < 0.05$ ).

**Conclusion:** The improvement of FRAP level, fitness function ( $VO_{2peak}$ ), and systolic blood pressure after performing 12-weeks of GQ promoting program can indicate that GQ promoting program is an alternative type of exercise which can reduce the risk of vascular disease in Mets group. With the indication stated, the GQ promoting program can be one of the health promotion strategies for Mets group. Furthermore, GQ

*promoting program is an exercise for both the mind and the body, easy to practice, cost efficient as well as pose many advantageous health benefits.*

**Keywords:** guang-im-ju-jai-gong qigong promoting program; plasma ferric reducing antioxidant power (FRAP) anti-oxidative capacity; metabolic syndrome

## Introduction

Metabolic syndrome (Mets) is a group of clinical metabolic disorders, including obesity, insulin resistance, glucose intolerance, hypertension and dyslipidemia. Also, it is the related component that extended the atherosclerotic and vascular disease.<sup>1</sup> Among the adult population worldwide, 20-25% of them have Mets.<sup>2</sup> The 4 th National Health Survey in Thailand portrays that there were 23.2% (19.5% in men and 26.8% in women) of the Thai adult age  $\geq 20$  years living with Mets. Mets was found to be higher in urban than rural areas (23.1% vs 17.9%). To minimize this health problem, a high socioeconomic cost is required.<sup>3</sup> The progression of Mets may lead to the vascular endothelial dysfunction which normally controls the vascular property. Endothelial dysfunction is an important factor in developing atherosclerosis and vascular disease. The people with risk factors of Mets need to modify their lifestyles, behaviors, or comply to medical treatments in order to reduce those risk factors including hyperglycemia, dyslipidemia, insulin resistance and hypertension or else severe pathologies and its complication may be prone to occur.<sup>4-5</sup>

Reactive oxygen species (ROS) are abundant, very reactive, and short-lived products of oxygen metabolism produced in all biological systems with nearby molecules at the site of formation. These species which contain the superoxide radical, the hydroxyl radical, and hydrogen peroxide are oxygen derivatives that play important roles in vascular biology. Oxidative stress, likewise mentioned to an ROS-antioxidant inequity, occurs when the net volume of ROS exceeds the antioxidant capacity. Therefore, oxidative stress

can arise as a magnitude of a general rise in ROS generation, a depression of the antioxidant system. ROS derived from various oxidation pathways can generate products leading to cellular dysregulation. The attraction of ROS effects to reduced biological activity, metabolic dysregulation, and variations in cell signaling and other cell function which have been associated in the pathogenesis of various diseases including atherosclerosis and cardiovascular disease. The natural antioxidant system consists of a series of antioxidant enzymes as well as numerous endogenous and dietary antioxidant compounds that react with inactivate ROS. Plasma ferric reducing antioxidant power (FRAP) is the method that is used to determine anti-oxidative stage in humans.<sup>6</sup>

Qigong, the Eastern Wisdoms and a favorite type of Traditional Chinese Medicine (TCM), had selected as the strategies to care and promote the people's health and practiced worldwide.<sup>7-8</sup> There are many types of Qigong namely, Frangrant Qigong,<sup>9</sup> Walking Qigong (Guolin Qigong),<sup>10</sup> and the oldest Qigong style called Eight Stand of Brocade Qigong (Ba Duan Jin).<sup>11</sup> It has been proven that Qigong can prevent and reduce the risk factors of many chronic diseases. Previously, the study in cancer patients found that it has an effect on inhibiting cancer growth.<sup>12</sup> In addition, Qigong also has an effect on mental parameters. A study found that Qigong can reduce the stress, depression, anxiety, and ultimately improve the quality of life.<sup>13-14</sup> For metabolic parameter, the randomized controlled trial show that Qigong has an effect in reducing the blood pressure in the mild essential hypertension group as well as the Blood sugar, HbA<sub>1c</sub>, and blood viscosity in type 2 DM.<sup>15-16</sup>

The decrease of those parameters can minimize the severity and complications of cardiovascular disease.

In terms of Guang-Im-Ju-Jai-Gong Qigong, it was developed by Qigong Master Yang and had been recommended to be practiced in Thailand as the complementary and alternative medicine by the Department of Thai Traditional and Complementary Medicine, Ministry of Public Health. Guang-Im-Ju-Jai-Gong Qigong had been verified that it was safe and beneficial for both of the healthy people and people with health problem.<sup>17-18</sup> Although Guang-Im-Ju-Jai-Gong Qigong has been reported as good for health, there has been no research or study which reports the effect of Guang-Im-Ju-Jai-Gong Qigong promoting program on anti-oxidative capacity in the Mets group.

### Objectives

The objective of this study was to measure the plasma anti-oxidative capacity in Mets group after performing the 12 week training of Guang-Im-Ju-Jai-Gong Qigong promoting program.

### Methods

An experimental research with randomized study was designed. A total of 55 sedentary female with Mets aged 40-65 years were studied in Bangkok, Thailand. The inclusion criteria included people with Mets, defined according the National Cholesterol Education Program, Adult Treatment Panel III (NCEP ATPIII),<sup>1</sup> who met at least three of the following five criteria: 1) obesity (waist men > 102 cm, women > 88 cm); 2) low high-density lipoprotein (HDL) cholesterol (men < 40 mg/dl; women < 50 mg/dl); 3) hypertriglyceridemia ( $\geq 150$  mg/dl); 4) elevated glucose ( $\leq 100$  mg/dl and < 126 mg/dl); and 5) elevated blood pressure ( $\geq 130/85$  mmHg or use of hypertensive drugs). The subjects were sedentary, free from CVD and diabetes, did not smoke cigarettes, and was not being treated for peripheral artery disease.

Exclusion criteria include T2DM ( $\text{HbA}_{1c} \geq 6.5\%$  or used of diabetic medication), pulmonary disease, atrial fibrillation, valvular heart disease, anemia, angina, myocardial infarction, ischemic heart disease, or coronary revascularization. All were assessed by physical examination, a detailed medical history, and a resting electrocardiogram. Subjects who regularly exercise for 30 minutes per time, 3 times per week for more than one month were also excluded. All subjects provided a 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 sample size was calculated by using the effects size of pilot study with the same GQ training protocol.<sup>19</sup> The subjects were randomized by block randomization and allocation concealment to control (n = 27) and GQ (n = 28) group. All measurements were the assessors blinding.

### Procedures

Guang-Im-Ju-Jai-Gong Qigong promoting program

GQ promoting programs consist of three parts; 1) arm swing (backward and forward) 500 repetitions, 2) 18 exercises posture, and 3) three sets of finger exercise. It was performed 1 hour a day, 4 days/week for the duration of 12 weeks in the quiet and ventilated environment without air conditioning. During those training sessions, the participants were to pay attention to inspiration and expiration of breathing, relaxation, and concentrate on the body alignment at standing position. Between each part of training, the participants performed energy storage postures in Duntain site (3 finger base below the umbilical) by male putting the right hand on the left hand and female putting the left hand on the right hand, then, turn both hand 36 rounds clockwise and 36 round counter-clockwise respectively. The participants performed GQ under the instructor's supervision at Bangsue community

health center. The instructors of the program were trained by the Qigong Master, Master Yang, through demonstration and self-practice for the duration of 2 consecutive years. They gather the experience from the teachings of the master and self-practice in order to be able to pass on Qigong techniques to the participants. In order to assure consistency throughout the training, the same 3 instructors were used all through the program.

## Measurements

### Ferric reducing antioxidant power (FRAP)

The antioxidant capacity was measured by Ferric reducing antioxidant power (FRAP) assay.<sup>6</sup> FRAP assay used antioxidants as reductants in a redox-link colorimetric method. At low pH, ferric tripyridyl triazine (Fe III TPTZ) complex was reduced to ferrous form (Fe III to Fe II) ion formation. The change in absorbance was directly related to the combination or total reducing power of the electrodonating antioxidants present in the reaction mixture. All blood samples were taken following an overnight 8-hour fasting period and did not exercise within 48 hrs. Three milliliters of blood were taken from the antecubital vein baseline and 12 weeks after GQ promoting program. Plasma was collected by using EDTA as an anticoagulant then centrifuge for 15 minutes at 1000 x g within 30 minutes of collection. The Assay was immediately aliquot and store samples at -80 °C. The measurements, specimen collection, and health education on self-preparation prior the blood test was carried by a nurse.

### Aerobic functional capacity

Peak oxygen consumption ( $VO_{2peak}$ ) was used to represent the aerobic functional capacity of each subject. It was measured during the incremental exercise test using the oxygen and carbon dioxide gas analyzer (Oxycon, USA). Oxygen consumption ( $VO_2$ ), Carbon dioxide production ( $VCO_2$ ), minute ventilation (VE), and other derived parameters were continuously

monitored breath-by-breath by a computerized system (Oxycon, USA). Data were expressed in a standard condition of standard temperature pressure dry (STPD). The Naughton's protocol for treadmill was used in the exercise test.  $VO_{2peak}$  criteria defined as follows; 1) the highest value of  $VO_2$  attain on the particular test, most commonly an incremental or other high intensity test, 2) cannot tolerate to the test, 3) chest pain, 4) abnormal of cardio-pulmonary system such cyanosis, fainting, loss of consciousness.<sup>20</sup> The measurements were conducted by the trained exercise physiologist who was trained and had at least 1 year experience of the instrument using.

### Anthropometric data

Body anthropometry including height, body weight, waist circumference (WC) and body mass index (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 by using a weight scale (Yamato DP-6100GP Japan) and BMI was calculated by dividing weight (kg) by height ( $m^2$ ). WC was measured at the superior border of the iliac crest and was taken to nearest 0.1 cm after a normal expiration.

### Statistical Analyses

All data were checked for normality then tested to a normal distribution if it was found to be violated. A statistical level of  $p < 0.05$  was considered a statistically significant difference. The data were expressed as mean  $\pm$  standard deviation. The Independent-Sample T-Test was used to identify the difference between groups and Paired-Sample T-Test for within the group difference.

## Results

The baseline characteristics of age, BMI, WC, blood pressure, FPG, triglyceride and HDL-C of the participants in both of groups, no significance dif-

ference when compared all of baseline characteristics (Table 1).  
in both of group ( $p > 0.05$ ) before training program

**Table 1** Subjects characteristics at baseline

Characteristic	Control (n=27)	GQ (n=28)	p-value
Age (years)	52.56 $\pm$ 2.56	51.00 $\pm$ 2.56	0.851
BMI (kg/m <sup>2</sup> )	26.24 $\pm$ 5.46	25.96 $\pm$ 4.17	0.716
WC (cm.)	88.18 $\pm$ 8.51	89.17 $\pm$ 10.43	0.298
SBP (mmHg)	134.26 $\pm$ 10.30	134.89 $\pm$ 15.72	0.221
DBP (mmHg)	81.04 $\pm$ 10.06	79.04 $\pm$ 10.19	0.890
FPG (mg%)	87.26 $\pm$ 13.86	87.96 $\pm$ 13.88	0.824
Triglyceride (mg%)	173.96 $\pm$ 28.46	173.86 $\pm$ 21.62	0.748
HDL-C (mg%)	47.64 $\pm$ 5.19	46.14 $\pm$ 8.48	0.758

Data express as mean  $\pm$  SD, 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.

The sample size consisted of 55 participants separated in to 2 groups. Post 12 weeks of Qigong training program, WC was decreased to lower than baseline from 89.17  $\pm$  10.43 to 86.71  $\pm$  10.96 cm but not statistical difference ( $p = 0.565$ ). No significant changes were observed on BMI in both groups. For

training effects of GQ, although the VO<sub>2peak</sub> was significant increased after 12 weeks in GQ from 23.58  $\pm$  4.56 vs 26.11  $\pm$  3.48 ml/kg/min ( $p = 0.022$ ). SBP was significantly decreased ( $p = 0.046$ ) in the GQ (134.89  $\pm$  15.72 vs 124.82  $\pm$  15.12 mmHg) and a significant difference with control group ( $p = 0.045$ ). For DBP (79.04  $\pm$  10.19 vs. 77.89  $\pm$  11.19), resting heart rate (67.21  $\pm$  8.01 vs. 66.68  $\pm$  9.20), and BMI (25.94  $\pm$  4.17 vs. 25.51  $\pm$  4.08) shows no significant differences in GQ group after training. (Table 2).

**Table 2** Changes In Anthropometric and Fitness 12-week of GQ promoting program

	Control (n=27)		GQ (n=28)	
	Pre	Post	Pre	Post
BMI(kg/m <sup>2</sup> )	26.24 $\pm$ 5.46	26.15 $\pm$ 5.26	25.96 $\pm$ 4.17	25.51 $\pm$ 4.08
WC(cm.)	88.18 $\pm$ 8.51	88.25 $\pm$ 8.64	89.17 $\pm$ 10.43	86.71 $\pm$ 10.96
Resting heart rate (beats/minute)	67.78 $\pm$ 9.55	68.26 $\pm$ 10.15	67.21 $\pm$ 8.01	66.68 $\pm$ 9.20
SBP (mmHg)	134.26 $\pm$ 10.30	132.89 $\pm$ 14.04	134.89 $\pm$ 15.72	124.82 $\pm$ 15.12*,†
DBP (mmHg)	81.04 $\pm$ 10.06	80.00 $\pm$ 17.96	79.04 $\pm$ 10.19	77.89 $\pm$ 11.19
VO <sub>2peak</sub> (ml/kg/min)	24.06 $\pm$ 6.09	24.38 $\pm$ 5.90	23.58 $\pm$ 4.56	26.11 $\pm$ 3.48*

Data expressed as mean  $\pm$  SD, BMI, body mass index; WC, waist circumference; VO<sub>2peak</sub>, peak oxygen consumption.

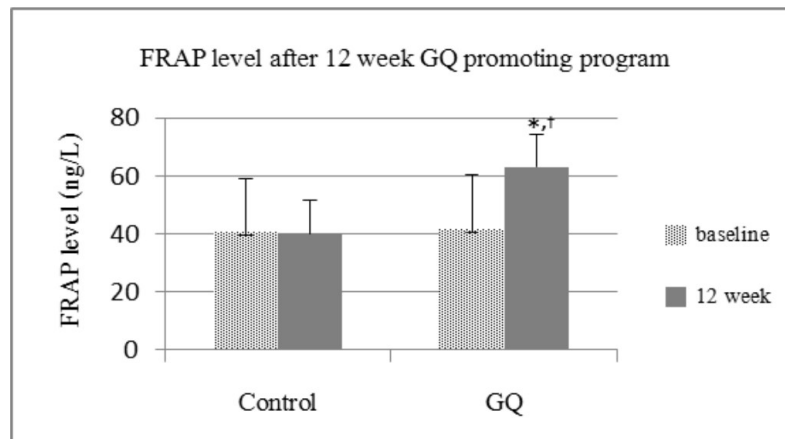
\* $p < 0.05$  vs. Pre, † $p < 0.05$  vs. control group,

### Change In Ferric reducing antioxidant power (FRAP) 12-week of GQ promoting program

After 12-weeks of GQ promoting program, FRAP were significantly improved from  $41.41 \pm 16.72$

to  $63.03 \pm 16.71$  ng/L and there was a significant difference when compared with baseline and control group ( $p < 0.05$ ) (Figure 1).

**Figure 1** Change in FRAP 12-week GQ promoting program



Data expressed as mean  $\pm$  SD, \* $p < 0.05$  vs. Pre, † $p < 0.05$  vs. control group

### Discussion

The findings of this study demonstrates that 12-week of Guang-Im-Ju-Jai-Gong Qigong could improve anti-oxidative capacity by increasing FRAP level, decreasing SBP, decreasing WC, and improve functional performance as shown by the elevation of  $VO_{2peak}$ .

The increasing anti-oxidative capacity of plasma FRAP level, is effected by relaxation the decreased of stress hormone<sup>9,21-22</sup> and increased parasympathetic activity during training.<sup>23</sup> The decrease of stress hormones such as cortisol activates vasodilation and the decrease stress force to endothelial cell effecting the increase of anti-oxidative capacity level.

In general, Qigong training consists of 2 components, mind and body movement. In the mind component of the Qigong practice, the participants focused on meditation, imagination, and breathing techniques which is believed to facilitate the energy circulation to the meridians and energy center.<sup>13</sup> Previous study show that Qigong effects relaxation

and decreased anxiety which results in the decrease of the cortisol hormone, adrenocorticotrophic hormone (ACTH), and increase beta-endorphin.<sup>9,21-22</sup> The cortisol and ACTH hormones are essential for vasoconstriction.<sup>24</sup> Moreover, the decreased stress hormone could improve vasodilation as shown in this study as the FBF increase after 12 weeks of Qigong training program. In addition, the decreased SBP and the improvement of vasodilation effect the reduction of total peripheral resistance of the vessel which is the main factor of blood pressure.

As for the skill of deep breathing technique of Qigong, Jarath<sup>23</sup> explained that mechanism of deep breathing technique had the effect on autonomic nervous system resulting in the decreased blood pressure and increased oxygen consumption by activating the parasympathetic activities as follows: 1) Activation of slowly adapting stretch receptors (SARs) and generate the inhibitory impulse in neural tissue then decrease action potentials in neural tissue, 2) Stretch of fibroblasts surrounding the lungs to generate hyperpolarization current then synchronize neural tissue including hypothalamus and brainstem, increasing



resting membrane potential polarity in surrounding tissues then decreasing metabolic activity.<sup>23</sup> Those are the mechanism to which explains the reason of reduced blood pressure and increased peak oxygen consumption of this study.

In terms of energy flow or Qi flow to along meridians, the new scientific knowledge called “Low hydraulic resistance”, describe the correlation of meridians with human organ function.<sup>25</sup> Kendall<sup>26</sup> also described that meridian stimulation could effect on the circulation of venous, arteries, and lymphatic system. All of these were the effects of gas exchange, vasodilation to increase endothelial function, decreased blood pressure, and improved oxygen consumption from the present study.<sup>26</sup>

For physical effect or Gong, Qigong has been known as a low intensity exercise. From the study of Chao, during 3 sets of Qigong practice, the cardiorespiratory response and energy expenditure about 3 Mets, 60 Kcal per set and estimated intensity approximated 50% of  $VO_{2max}$  for men and 60%  $VO_{2max}$  for women.<sup>27</sup> The standing position and finger exercise of Qigong resulted in alternate between isometric and isotonic muscle contraction. During the light muscle contraction, intramuscular pressures increased due to swelling and stiffening of the muscle activity and develop slow twist muscle activity producing an aerobic metabolism of muscle fiber to generate energy for movement. In addition, the adaptation mechanisms can effect on the increase peak oxygen consumption and decrease WC.<sup>28</sup> Low intensity exercise triggers aerobic metabolism and stimulates shear stress to endothelial cell, thereafter increasing nitric oxide activity which effects on vasodilation.<sup>29</sup>

## Conclusion

This study indicates that performing Guang-Im-Ju-Jai-Gong Qigong in Mets group can improve anti-oxidative capacity, blood pressure, and cardio-

respiratory fitness. Although GQ is an alternative type of exercise, it can reduce the risk of endothelial dysfunction in Mets group by increasing the anti-oxidative capacity which reducing oxidative stress in endothelial cell. The continuation of training (12 weeks, 4 day per week, and 1 hour per day) would be ideal for one of the health promotion strategies for Mets group. Moreover, GE is both an exercise for both the mind and body, easy to practice, no required instruments, more cost efficient than other types of exercises, and may provide advantageous health benefits.

## Recommendations and Implications

Qigong is one of the Eastern Wisdoms which convenience, appropriate and safe for applying as the health promotion strategies in the Mets group and other people. According this study results, it increased anti-oxidative capacity and physical fitness.

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