Community-Based Mind−Body Meditative Tai Chi Program and Its Effects on Improvement of Blood Pressure, Weight, Renal Function, Serum Lipoprotein, and Quality of Life in Chinese Adults With Hypertension

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Obesity, metabolic syndrome, dyslipidemia, and poor quality of life are common conditions associated with hypertension, and incidence of hypertension is age dependent. However, an effective program to prevent hypertension and to improve biomedical factors and quality of life has not been adequately examined or evaluated in Chinese older adults. This study aims to examine the effectiveness of a Tai Chi program to improve health status in participants with hypertension and its related risk factors such as dyslipidemia, hyperglycemia, and quality of life in older adults in China. A randomized study design was used. At the conclusion of the intervention, 266 patients remained in the study. Blood pressure and biomedical factors were measured according to the World Diabetes Association standard 2002. A standardized quality-of-life measure was used to measure health-related quality of life. It was found that a Tai Chi program to improve hypertension in older adults is effective in reducing blood pressure and body mass index, maintaining normal renal function, and improving physical health of health-related quality of life. It did not improve existing metabolic syndrome levels, lipid level (dyslipidemia) or fasting glucose level (hyperglycemia), to prevent further deterioration of the biomedical risk factors. In conclusion, Tai Chi is effective in managing a number of risk factors associated with hypertension in Chinese older adults. Future research should examine a combination of Tai Chi and nutritional intervention to further reduce the level of biomedical risks. **(Am J Cardiol 2015;116:1076−1081)**

Despite the potential of Tai Chi to manage conditions such as heart failure,[1] there have been few studies examining its potential to improve health and manage patients with hypertension in China. Most studies that have been conducted had short-term interventions, ranging from 8 to 16 weeks,[2−4] and there are no studies that have examined the longer term effects (e.g., >12 months) of Tai Chi to improve health in hypertensive patients. The purpose of this study was to examine the effectiveness of a 12-month mind−body meditation intervention program on improvement of blood pressure (BP), body mass index (BMI), dyslipidemia, and quality of life in Chinese adults with hypertension. It was hypothesized that hypertensive participants participating in Tai Chi would have

(1) Significant reduction in BP and BMI levels;
(2) Significant improvement in biochemical markers including total cholesterol, low-density lipoprotein (LDL), high-density lipoprotein (HDL), triglycerides (TG), and estimated glomerular filtration rate (eGFR); and
(3) Improved psychosocial outcomes including quality of life.

Methods

This study used a randomized study design to investigate the effectiveness of mind−body meditation approach on improvements BP, BMI, lipid profiles, and quality of life factors associated with hypertension and age-related chronic disease. The study population consisted of a sample of Chinese adults aged 45 to 80 years in Changshu, Jiangsu Province, and Fang Shan District, Beijing, China. Both Changshu and Fangshan were selected as the study sites because of their well-developed economic status in China, which has resulted in dramatic changes in the lifestyle, dietary, and disease patterns of the residents in recent years. The trial was registered in International Standard Randomized Controlled Trial with Number ISRCTN 87289137 (Web address: *http://www.controlled-trials.com/ISRCTN87289137*). Ethical approval was obtained from the Jiangsu Province Changshu Center for Disease Control and Prevention (CDC) and Fang Shan CDC Research Review Committee in China and the Griffith University Research Ethics Committee in Australia.

To be included in the study, participants had to be aged ≥45 years and diagnosed with hypertension. This age group was chosen because they have an increased prevalence of hypertension,[5,6] providing a unique opportunity to observe risk factors associated with this condition. Participants also had to be resident in Changshu city of Jiangsu Province or in the Fangshan District of Beijing, within 20 km of the metropolitan area. Participants who met these criteria were randomly selected from medical records located in the

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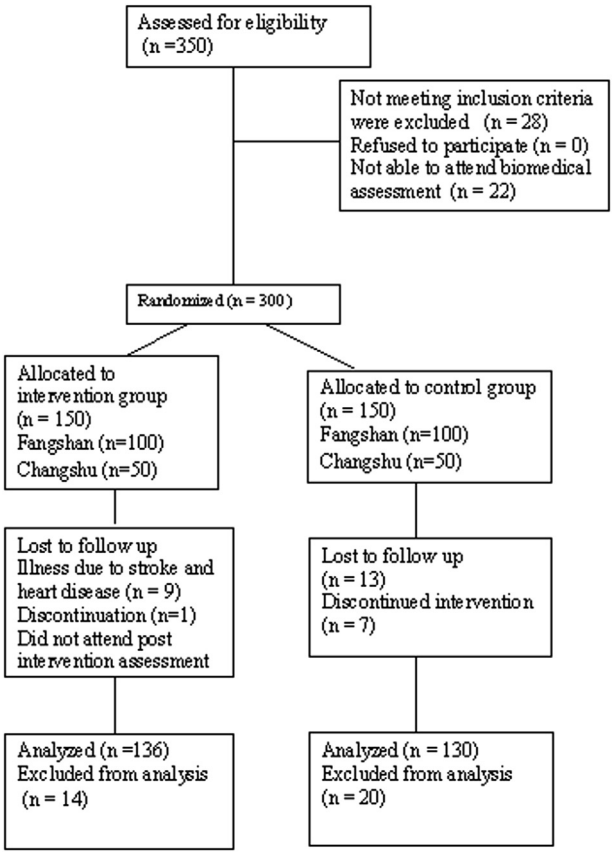

Figure 1. Consort chart of recruitment of participants.

Table 1
Characteristics of participants in Tai Chi intervention group (n=136) and control group (N=130)

Characteristics	Intervention group (n=136)	Control group (n= 130)	χ^2	*p*
Age (Years)				
45−64	87(64%)	90(70%)	1.18	0.28
≥ 65	49(36%)	40(30%)		
Gender				
Female	117(86%)	101(78%)	2.84	0.09
Male	19(14%)	29(22%)		
Education (Years)				
<10	61(45%)	50(39%)	5.19	0.06
10−12	43(31%)	60(46%)		
Bachelor and above	32(24%)	20(15%)		
Employment				
Retired	132(97%)	126(98%)	3.86	0.10
Others	4(3%)	4(2%)		
Marital status				
Married	128(94%)	112(86%)	4.44	0.11
Widowed	4(3%)	12(9%)		
Never married	4(3%)	6 (5%)		
Income				
<20,000 RMB	57(42%)	51(39%)	0.43	0.81
20,000-39,999 RMB	58(43%)	55(42%)		
≥40,000 RMB	21(15%)	24(19%)		

Notes. Chi-square test was used to compare the difference between normal and hypertension group participants.

Changshu CDC and Fang Shan CDC. They then participated in a clinical interview conducted by trained physicians at the CDC or the Bureaus of Health in Changshu City and Fangshan District in Beijing. At the same time, a medical examination was conducted and a medical history taken regarding experience of chronic diseases. Participants were also asked to provide a biomedical blood sample and complete a survey measuring health-related quality of life (HRQoL) and demographic factors. People were excluded from the study if they had a neurologic impairment or could not provide consent to participate.

Of the 350 people who met the inclusion criteria, 300 participated in the clinical interview, blood sample test, and survey, representing a high response rate of 86%. All participants presented with hypertension at the time of data collection or were on hypertensive medication. Equal numbers of participants were randomly assigned to the Tai Chi intervention group (n = 150) and control group (n = 150) by the 3 physicians using a simple randomization method (Figure 1). Researchers who conducted the statistical analysis and who conducted the laboratory tests were not aware of the allocation status of the participants. The sample met the statistical power requirement for a moderate effect size on systolic blood pressure (SBP) of 0.47.[1]

Participants in the intervention group attended Tai Chi training for 12 months from April 2012 to April 2014, whereas control group participants were active controls who attended non−exercise-related activities such as reading and learning computer software applications for the same period. In the Tai Chi group, participants were taught a variety of meditation techniques by an experienced trainer including breathing, balance, flexibility, concentration, calming, and stress-reduction techniques. Both Tai Chi and control group participants participated in group activities 3 h/wk and 2-hour practice by themselves at home.

After the completion of interview, data were collected using a combination of biomedical assessments and standardized questionnaires as part of a free physical examination. Participants were required to fast overnight. Fasting venous blood samples were then collected and analyzed for biomedical indicators, including total cholesterol, LDL, HDL, TG, fasting glucose, and serum creatinine (Scr). Participants, wearing light indoor clothing without shoes, were then weighed to the nearest 0.1 kg and measured to the nearest 0.1 cm in height. BMI was calculated as weight (kg)/height (m^2). The China CDC and Ministry of Health adopted the World Diabetes Federation criteria,[7] which is based on the BMI, and defines overweight as 25.0 to 29.9 kg/m^2 and obesity as ≥30.0 kg/m^2. Waist (centimeters) girth was measured at the minimum circumference between the iliac crest and the rib cage using an anthropometric tape over light clothing. Abdominal obesity was defined as waist circumference ≥90 cm for men and ≥80 cm for women, on the basis of the World Federation Diabetes standard.[8] SBP and diastolic blood pressure (DBP) were measured using an inflatable cuff wrapped around the upper arm (not the forearm or wrist) and attached to an electronic monitor that gave a digital readout of the BP (mm Hg) and pulse.

Table 2
Differences between pre intervention and post intervention in blood pressure, biomedical factors in both Tai Chi and control group participants

Variables	Group	N	Baseline Mean(SD)	12 month Mean (SD)	P value		
					Group	Time	Interaction
1. Systolic blood pressure (mm Hg)	Taichi	136	130.71 ± 16.65	120.28 ±14.63	**0.04**	**<0.001**	**0.02**
	Control	130	130.46 ± 15.97	128.13 ± 14.55			
2. Diastolic blood Pressure (mm Hg)	Taichi	136	82.21 ± 7.94	75.31 ±14.53	**0.008**	**<0.001**	**0.007**
	Control	130	81.92 ± (8.25	79.58 ±12.44			
3. Serum total cholesterol (mmol / L)	Taichi	136	4.75 ± 1.15	4.81 ± 0.95	0.54	0.11	0.71
	Control	130	4.65 ± 3.16	5.49 ± 0.97			
4. High-density lipoprotein cholesterol (mmol / L)	Taichi	136	1.57 ± 0.55	1.59 ± 0.34	0.91	0.18	0.15
	Control	130	1.49 (0.62)	1.63 (0.37)			
5. Triglycerides (mmol / L)	Taichi	136	1.66 ± 1.03	1.92 ± 0.98	0.58	0.22	0.84
	Control	130	1.58 ± 1.37	1.96 ± 1.03			
6. Low-density lipoprotein (mmol / L)	Taichi	136	2.72 ± 0.87	2.73 ± 0.79	0.24	0.30	0.30
	Control	130	2.59 ± 1.11	5.41 ± 2.82			
7. Fasting glucose (mmol / L)	Taichi	136	5.65 ± 1.22	5.88 ± 0.63	0.64	**0.005**	0.94
	Control	130	5.50 ± 2.17	6.07 ± 0.95			
8. Estimated Glomerular Filtration Rate (mL/min/1.73m^2)	Taichi	136	90.77 ± 10.28	91.00 ± 10.68	0.85	**<0.001**	**0.002**
	Control	130	92.42 ± 9.70	82.86 ± 11.96			
9. Waist (cm)	Taichi	136	76.06 ± 6.86	75.73 ± 7.56	0.84	0.27	0.99
	Control	130	79.82 ± 4.80	79.49 ± 8.27			
10. Body Mass Index (kg/m^2)	Taichi	136	23.38 ± 3.05	22.25 ± 2.91	**0.03**	**<0.001**	**0.04**
	Control	130	23.50 ± 2.99	23.16 ± 2.94			

Notes. p-values were calculated using two-way repeated-measures general linear model. Statistical significant difference between pre and post intervention time: $p < 0.05$. Figure in bold indicates statistical significance.

Table 3
Relationship between eGFR and systolic blood pressure, diastolic blood pressure and body mass index

Variables	Regression Coefficient (95% CI)	Beta	P
Systolic blood pressure	-0.15 (-0.25 to -0.04)	-0.19	0.005
Diastolic blood pressure	0.24 (0.06-0.42)	0.17	0.01
Body mass index	-0.40 (-0.81 to 0.01)	-0.10	0.05

Multiple linear regression was used to analyze the relationship between eGFR and systolic blood pressure, diastolic blood pressure and body mass index; Statistical significance $p < 0.05$.

The criteria for hypertension are SBP >140 mm Hg and DBP >90 mm Hg, on the basis of the International Diabetes Federation (IDF)[7] and China CDC criteria.[8]

Metabolic syndrome was based on the updated IDF criteria.[8] Metabolic syndrome was diagnosed by the presence of central obesity assessed as mentioned previously (using cut-off values from Chinese people), plus on at least 2 other components including high TG (>1.69 mmol/L), low HDL (HDL <1.03 mmol/L for men and <1.29 mmol/L for women), elevated BP (SBP ≥130 mm Hg or DBP ≥85 mm Hg), and hyperglycemia (fasting glucose ≥5.6 mmol/L). Dyslipidemia was defined as total cholesterol ≥5.17 mmol/L, LDL ≥4.1 mmol/L, HDL-C <1.03 for men and <1.29 for women, and/or TG >1.69 mmol/L, according to the IDF definition.[8] eGFR was used to measure renal functions using the following equation of the Modification of Diet in Renal Disease Study for Chinese eGFR (mL/min/1.73 m^2) = $186 \times [\text{Scr}]^{-1.154} \times [\text{age}]^{-0.20} \times [0.74$ (if female)] × [1.23 (Chinese co-efficient)].[9]

HRQoL were measured using the Short-Form 12 Health Survey, which has 12 items and is a reliable and valid means of measuring quality of life in people with chronic conditions.[10] Two aggregate physical and mental component summary scores were also calculated on the basis of Chinese population norms.[11] The physical health components of the Short-Form 12 Health Survey encompass (1) physical functioning; (2) role limitations due to physical health problems; (3) bodily pain; and (4) general health perception. The mental health component includes (1) vitality/fatigue; (2) social functioning; (3) role limitation due to emotional problems; and (4) mental health status.

The chief investigators were blind to the allocation of the participants. The percentage of normal and abnormal biomedical levels in a number of biomedical factors in both Tai Chi intervention group and control group at the baseline phase was compared using the chi-square test. All continuous variables were checked for normal distribution before multivariate general linear model (GLM) was used to compare differences before and after intervention in both the Tai Chi group and control group on biomedical factors and HRQoL measurements as continuous variables. Any differences between the Tai Chi and control group on demographic factors including age, gender, education, income, and marital status were controlled in the GLM when the intervention effect was analyzed. The statistical significance level was at a p value <0.05 for the chi-square and GLM tests. All statistics were conducted on the remaining participants after intervention. To examine sample biases, participants in both the intervention and control groups were compared before and after intervention on age, gender, education, income, employment, and marital status.

Table 4
Differences between pre intervention and post intervention time in intervention and control group participants in quality of life

Variables	Group	N	Baseline Mean (SD)	12 month Mean (SD)	P value		
					Group	Time	Interaction
1. Physical functioning	Taichi	136	55.13 ± 14.91	54.44 ± 15.74	**0.02**	0.95	0.65
	Control	130	50.16 ± 17.11	51.08 ± 17.22			
2. Role Physica	Taichi	136	83.27 ± 20.03	94.58 ± 10.72	**<0.001**	**0.003**	**0.01**
	Control	130	81.27 ± 18.90	82.06 ± 20.11			
3. Bodily pain	Taichi	136	79.48 ± 22.30	90.83 ± 16.72	**<0.001**	**0.008**	**0.05**
	Control	130	75.00 ± 23.74	76.79 ± 22.89			
4. General health	Taichi	136	44.32 ± 25.20	48.33 ± 24.51	**0.002**	0.14	0.95
	Control	130	52.51 ± 23.89	56.17 ± 23.10			
5. Vitality	Taichi	136	74.40 ± 22.01	84.17 ± 17.96	**0.005**	**0.003**	**0.05**
	Control	130	68.62 ± 27.23	74.84 ± 22.78			
6. Social functioning	Taichi	136	68.13 ± 17.37	70.67 ± 17.21	**0.03**	0.35	0.73
	Control	130	64.40 ± 19.18	65.58 ± 17.64			
7. Role emotional	Taichi	136	85.21 ± 17.35	88.75 ± 17.48	**0.02**	0.15	0.73
	Control	130	81.42 ± 19.21	83.60 ± 18.55			
8. Mental Health	Taichi	136	81.13 ± 16.41	85.00 ± 17.80	**0.02**	**0.12**	0.71
	Control	130	77.09 ± 19.79	79.46 ± 19.68			
Physical total score	Taichi	136	73.16 ± 15.59	81.05 ± 9.64	**0.006**	**0.004**	**0.05**
	Control	130	71.45 ± 16.32	73.41 ± 14.92			
Mental total score	Taichi	136	83.42 ± 12.99	87.69 ± 11.71	**0.002**	**0.03**	0.60
	Control	130	79.34 ± 15.50	81.99 ± 14.22			

Notes. p-values were calculated using two-way repeated-measures general linear model. Statistical significant difference between pre and post intervention time: $p < 0.05$. Figure in bold indicates statistical significance.

Results

The recruitment and study procedure is illustrated in Figure 1. At baseline, 300 patients were assessed in the preintervention phase of the study. During the intervention period, 14 patients in the Tai Chi group were excluded in the final data analysis because of illness (n = 9), discontinuation from the activity (n = 1), and/or failure to attend the post-intervention assessment (n = 4). Of those who were excluded from the final analysis, the attrition rate was 9%. In the control group, a total 20 participants (13% attrition rate) were excluded from the final analysis because of discontinuation (n = 13) and failure to attend the postintervention assessment (n = 7). The total number of participants included in the final analysis was 136 in the intervention group and 130 in the control group.

Table 1 summarizes the differences between Tai Chi intervention participants on demographic characteristics. All participants in the Tai Chi intervention group were of Han ethnic origin, the main ethnic group in China. The results indicate there were no significant differences between the Tai Chi group and control group on age, gender, employment, marital status, and income. Baseline characteristics related to cardiovascular risk factors and quality of life indicate no statistical differences between the intervention and control groups on cardiovascular risk factors including SBP, DBP, total cholesterol, LDL, HDL, TG, glucose, eGFR, waist, BMI, and quality of life factors. There were significant differences between the intervention and control groups on physical functioning and general health. There was no difference between the participants in the preintervention period and those who remained to the postintervention period on age, gender, education, income, and marital status in both intervention and control groups.

As indicated in Table 2, significant interactions between group and time were obtained from the repeated-measures GLM analysis in SBP, DBP, BMI, and eGFR (Table 2). These findings indicated that the changes over time on these variables were significantly different between the Tai Chi and control groups. Specifically, intervention group participants at the postintervention had much lower SBP, DBP, and BMI than at preintervention, with a 10-point difference for SBP, 7 points for DBP, and 1 point for BMI. All Tai Chi participants at postintervention had a BMI at the normal level (22.3 ± 2.9), whereas at preintervention, they had a mean BMI of 23.4 (standard deviation is 3.1). All participants in both the Tai Chi and control groups had a normal eGFR score (90.77 vs 92.42) at preintervention. At postintervention, in the Tai Chi group, the eGFR score (91.01) remained at normal levels. However, the control group had a significant decrease in eGFR score (82.06) from a normal to a marginal level.

There was also a significant interaction between group and time in eGFR, in that the change over time in kidney functioning was significantly different between Tai Chi and control groups, suggesting the Tai Chi group had maintained or significantly improved kidney functioning compared to the control group. There were no statistical significant interactions between group and time on lipid components and glucose factors. There was also no significant interaction between group and time on waist circumference, suggesting the changes over time in lipid components, glucose factors, and waist circumference were not significantly different between the Tai Chi and control groups. The relation between eGFR and SBP, DBP, and BMI in Tai Chi group was further analyzed through a multiple linear regression analysis. This found that the improvement of eGFR was significantly related to the improvement of SBP, DBP, and BMI (Table 3).

Table 4 demonstrates that there were improvements on quality-of-life measurements for Tai Chi group participants after intervention compared to before intervention in physical role, bodily pain, vitality, and total physical health. These findings were significantly different between the Tai Chi and control groups. There were also significant differences between group and preintervention and postintervention time on the mental health subscale and overall mental health score, but there were no significant interactions between group and time on these factors, suggesting both groups improved their mental health at a similar magnitude.

Discussion

To our knowledge, this is the first randomized control trial and community-based program study to explore the long-term effects of habitual Tai Chi exercise on BP and quality of life using a large sample of patients with hypertension in China. These findings indicate a greater improvement over time in SBP, DBP, BMI, eGFR, physical health scales (including role physical health plays, bodily pain, and total physical health score on the HRQoL), and vitality scale of mental health HRQoL in the Tai Chi group compared to the control group.

Clinically significant improvement in BP and BMI were found between preintervention and postintervention time in Tai Chi participants compared to the control group. In this context, these are the first Chinese findings to demonstrate that Tai Chi may be an effective adjunct at a community level to primary prevention in improving BP of patients with hypertension. Lower BP in the Tai Chi group after intervention indicates that this activity is effective in reducing BP in hypertensive patients. This supports previous results reported for people with mild hypertension, in which a significant reduction of high-level SBP was found after 12 weeks of Tai Chi exercise[12] and 24 months of Tai Chi exercise.[13] Previous studies have reported inconsistent results regarding the effects of Tai Chi on BMI and waist circumference improvement. The significant improvement of BMI found in the present study may be because Tai Chi is an activity that requires routine and regular exercise and long-term training for the effects on BMI to be significant. The significant reduction of BP and BMI in hypertensive patients may be present because Tai Chi training can improve metabolic functioning by influencing insulin sensitivity, the partitioning of fuels toward oxidation rather than storage.[14]

Our study did not found that Tai Chi was effective in preventing deterioration in biomedical factors including total cholesterol, LDL, HDL, TG, and glucose. As hypertension and dyslipidemia frequently co-exist,[15,16] people with these conditions have an increased risk of cardiovascular disease compared to people with individual risk factors.[17,18] The relation between glucose abnormalities and hypertension may exist because hyperinsulinemia directly contributes to elevated BP. The nonsignificant change in these biomedical factors including total cholesterol, LDL, HDL, TG, and glucose in the Tai Chi group may be due to that patients were not advised to reduce the dietary fat intake level. It has been suggested that lipid profiles such as total cholesterol and HLD cannot be modified by Tai Chi unless dietary fat intake is reduced.[13]

Tai Chi exercise was significantly related to prevention of deterioration on eGFR measuring renal function in the Tai Chi group compared with the control group, which had a significantly decreased eGFR. With the reduction of BP and weight, the renal functioning in the Tai Chi group has remained at a normal level. This may be because eGFR was significantly related to the improvement of SBP, DBP, and BM. Our results on eGRF suggest that renal function may depend on the level of BP and weight. This result is in consistent with Shi et al[9] who have found a significant positive effect of a 12-week Tai Chi exercise program on renal function.

Participants in the Tai Chi group reported significantly greater scores in HRQoL after intervention versus before intervention compared to control group participants, although the degree of difference varied across the components of HRQoL. Intervention participants after intervention versus before intervention had greater scores in areas such as role physical health plays, reduced bodily pain, and total physical health scores, compared to control group participants. These results are consistent with the findings of previous studies using Tai Chi treatment on people with elevated blood glucose or diabetes[19] that demonstrated a significant improvement in physical health component of the quality of life. These findings suggest that Tai Chi may have had a role in helping people to become more physically healthy.

Tai Chi exercise was significantly related to high scores only on vitality scales measuring mental health in the intervention group. This is consistent with previous research that found that Tai Chi improved vitality and mental health and better social functioning, mood, and psychological functioning than did control groups.[20] Tai Chi has no significant effect on other mental health scales and total mental health score. One explanation for our result is that most patients had normal or above-average mental health status, as measured by the HRQoL, because of their supportive communities and family environments. Another explanation is that the control group was an “active” control group, with people also participating in social interaction with other participants during the intervention, and that these social activities may have the same effect as the Tai Chi exercise, sustaining mental health and preventing deterioration.

A possible limitation of the study is that the sample was restricted to only 2 regions in China which may limit the generalization of the results to other areas and regions in the country. Furthermore, the study only focused on older adults, a group which may have poor physical health related to age rather than hypertension per se. Further studies are required to extend the study to more areas and regions and include other age groups. Despite these limitations, the use of a randomized controlled trial in this study provides empirical support for the casual link between Tai Chi exercise and improvement of BP, BMI, quality of life, and maintaining renal function in patients with hypertension.

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Disclosures

The authors have no conflicts of interest to disclose.

1. Sun J, Buys N, Jayasinghe R. Effects of community-based meditative Tai Chi programme on improving quality of life, physical and mental health in chronic heart-failure participants. *Ageing Ment Health* 2014;18:289−295.
2. Barrow DE, Bedford A, Ives G, O'Toole L, Channer KS. An evaluation of the effects of Tai Chi Chuan and Chi Kung training in patients with symptomatic heart failure: a randomised controlled pilot study. *Postgrad Med J* 2007;83:717−721.
3. Channer KS, Barrow D, Barrow R. Changes in haemodynamic parameters following Tai Chi Chuan and aerobic exercise in patients recovering from acute myocardial infarction. *Postgrad Med* 1996;72:349−351.
4. Yeh GY, McCarthy EP, Wayne PM, Stevenson LW, Wood MJ, Forman D, Davis RB, Phillips RS. Tai chi exercise in patients with chronic heart failure: a randomized clinical trial. *Arch Intern Med* 2011;171:750−757.
5. Li XH, Qiao Y, Li BJ, Li CX. Prevalence and awareness of hypertension in Gansu Gannan Tibetan adult population. *Zhonghua Xin Xue Guan Bing Za Zhi* 2012;40:527−529.
6. Gu D, Jiang H, Wu XG, Reynolds K, Gan WQ, Liu DH, Su SY, Duan XF, Huang GY, Whelton PK. Prevalence, awareness, treatment and control of hypertension in Chinese adults. *Chin J Prev Med* 2003;37:84−89.
7. Alberti KG, Zimmet P, Shaw J. Metabolic syndrome−a new worldwide definition. A Consensus Statement from the International Diabetes Federation. *Diabet Med* 2006;23:469−480.
8. Wu A, Kong N, de Leon F. An alarmingly high prevalence of diabetic nephropathy in Asian type 2 diabetic patients: the MicroAlbuminuria Prevalence (MAP) Study. *Diabetologia* 2005;48:17−26.
9. Shi ZM, Wen HP, Liu FR, Yao CX. The effects of tai chi on the renal and cardiac functions of patients with chronic kidney and cardiovascular diseases. *J Phys Ther Sci* 2014;26:1733−1736.
10. Sanderson K, Andrews G. The SF-12 in the Australian population: cross-validation of item selection. *Aust N Z J Public Health* 2002;26:343−345.
11. Hu J, Gruber KJ, Hsueh KH. Psychometric properties of the Chinese version of the SF-36 in older adults with diabetes in Beijing, China. *Diabetes Res Clin Pract* 2010;88:273−281.
12. Tsai JC, Wang WH, Chan P, Lin LJ, Wang CH, Tomlinson B, Hsieh MH, Yang HY, Liu JC. The beneficial effects of Tai Chi Chuan on blood pressure and lipid profile and anxiety status in a randomized controlled trial. *J Altern Complement Med* 2003;9:747−754.
13. Chang RY, Koo M, Chen CK, Lu YC, Lin YF. Effects of habitual t'ai chi exercise on adiponectin, glucose homeostasis, lipid profile, and atherosclerotic burden in individuals with cardiovascular risk factors. *J Altern Complement Med* 2013;19:697−703.
14. Tsatsoulis A, Fountoulakis S. The protective role of exercise on stress system dysregulation and comorbidities. *Ann N Y Acad Sci* 2006;1083:196−213.
15. Haffner SM, Miettinen H, Gaskill SP, Stern MP. Metabolic precursors of hypertension. The San Antonio heart study. *Arch Intern Med* 1996;156:1994−2001.
16. Oparil S, Zaman MA, Calhoun DA. Pathogenesis of hypertension. *Ann Intern Med* 2003;139:761−776.
17. Castelli WP, Anderson K. A population at risk. Prevalence of high cholesterol levels in hypertensive patients in the Framingham Study. *Am J Med* 1986;80:23−32.
18. Stamler J, Wentworth D, Neaton JD. Prevalence and prognostic significance of hypercholesterolemia in men with hypertension. Prospective data on the primary screenees of the Multiple Risk Factor Intervention Trial. *Am J Med* 1986;80:33−39.
19. Liu X, Miller YD, Burton NW, Chang JH, Brown WJ. The effect of Tai Chi on health-related quality of life in people with elevated blood glucose or diabetes: a randomized controlled trial. *Qual Life Res* 2013;22:1783−1786.
20. Wang CC, Collet JP, Lau J. The effect of tai chi on health outcomes in patients with chronic conditions: a systematic review. *Arch Intern Med* 2004;164:493−501.