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Effects of a Graded Brisk Walking Test at Different Levels of Intensity on Elderly Patients with Essential Hypertension: A Randomized Controlled Trial Study in Shanghai, China

Ming Xu[1], Ting Xiao[2], Tao Wang[3*] and Enhong Dong[4*]

[1]Department of Outpatient Office, Nanmatou Community Health Service Center, Pudong New Area, Shanghai, China
[2]Department of Healthcare, Shanghai Tenth People's Hospital, Tongji University, Shanghai, China
[3]Department of Emergency, Shanghai East Hospital, Tongji University School of Medicine, Shanghai, China
[4]Department of Nursing and Health Management, Shanghai University of Medicine and Health Science, Shanghai, China

***Corresponding author:** Tao Wang, Department of Emergency, Shanghai East Hospital, Tongji University School of Medicine, Shanghai, China, E-mail: 18521316637@163.com

Enhong Dong, Department of Nursing and Health Management, Shanghai University of Medicine and Health Science, Shanghai, China, E-mail: kevindong8012@163.com

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Abstract

Objective: Aiming to clarify the effect of a Graded Brisk Walking Test (GBWT) program on blood pressure control in elderly patients with essential hypertension, and degree of intensity of this exercise program that is appropriate for the elder people.

Results: An ANOVA showed that there was no significant time main effect, condition main effect, or time by condition interaction both in HR and BMI indicators (all P>0.05).The ANOVA revealed significant condition main effects, time by condition interaction or time main effects in blood pressure (F=21.875,33.457,65.342, respectively, all P<0.05). After intervention, there also showed significant differences both in SBP and DBP values for two groups (all P<0.05), and average values of the intervention group were significantly lower than those of the control group from baseline to the second phase (all P<0.05). Significant differences in the blood pressure values after the first two phases were also observed, compared with those before the intervention. Similarly, a significant difference in BP between the first phase and the second phase in the intervention group was also found. However, after the third phase (24 weeks, high-intensity exercise), no significant differences existed both in SBP and DBP values compared with those before the intervention (P=0.07).

Keywords: Essential hypertension; Graded brisk walking test; Elderly patients

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Introduction

Hypertension is widely known as a major risk factor for cardiovascular diseases. Approximately 62% of stroke diagnoses and 49% of cardiovascular diagnoses are directly related to hypertension [1]. Essential hypertension is a major risk factor for various cardiovascular diseases [2]. Given traditional clinical medication can cause numerous adverse reactions and addiction in patients, some studies on exercise therapies have focused on physical education rather than medicine. Many studies have shown that strengthening exercises and physical activity can help reduce blood pressure in patients with hypertension, for example, walking is the most popular, simplest, and safest form of strengthening exercise, which can improve physical and psychological health and is a crucial adjuvant therapy for various diseases, particularly hypertension [3]. Especially for Chinese older people, who care more about the therapeutic cost of chronic diseases, clarifying the standards and appropriate intensity of exercise therapies is crucial [4-9]. The Graded Brisk Walking Test (GBWT), as a valid, responsive, controllable self-paced walking test, quantifies functional exercise capacity as the distance walked in a few minutes and is recommended by many health practitioners [10,11]. It was transformed from a graded exercise program, which was usually delivered in a clinic by specialist therapists with up to 15 sessions over 3-6 months, and supervised by a specialist physiotherapist. It is safe and can be used to reduce physical disability, or reduce fatigue for some people, especially those with Chronic Fatigue Syndrome (CFS), while it can be expensive to deliver and access to clinics providing these treatments is limited. Accordingly, the GBWT was imitatively developed, popularly carried out among elderly people and later applied to economic and safe environments, such as home-based or community-based surroundings. As a new way of strengthening exercise, the GBWT is categorized into three different levels: low, moderate, and vigorous and depending on steps subjects walk and are gradably measured by

the metabolic equivalent of task. However, to what extent this walking exercise can reduce blood pressure like other exercises, and what intensity standard of this walking exercise reducing blood pressure is appropriate for elderly patients with essential hypertension still remains inconclusive. The research questions of this study were: What is the therapeutic effect of the "GBWT" walking exercise on blood pressure control in elderly patients with essential hypertension? And what degree of intensity of this exercise prescription is appropriate for those?

Methodology

Subject enrolment

The participants were recruited from a Chinese community named Nanmatou Street, located in Shanghai of China from March to September 2018. Inclusion criteria for the patients were: patient with a confirmed diagnosis of hypertension; those aged 55 to 79 years; those diagnosed with essential hypertension in accordance with the 2010 Guidelines for Preventing and Treating Hypertension in China; those who continuously or cumulatively are residing in the community for 6 months or more in the past year; those who have failed to stabilize their blood pressure (Systolic Blood Pressure (SBP) of ≥ 140 mmHg and Diastolic Blood Pressure (DBP) of ≥ 90 mmHg) using normal medication; Exclusion criteria for them were: patients with secondary hypertension, those with unstable angina or acute myocardial infarction within 1 month prior to this study; those with liver or kidney dysfunction; those with thyroid function disorder; those with a resting heart rate of>120 bpm; those with malignant arrhythmia; those with frailty and extreme obesity; and those with severe valvular diseases, joint diseases, neurological diseases, or mental disorders, which could affect the results of the GBWT.

Inclusion criteria for the healthy subjects were: those aged 55-79 years; having normal blood pressure (SBP ≦ 120 mmHg, and/or DBP ≦ 80 mmHg); no alcohol and no smoking history. Patients and healthy controls were age and gender-matched, while SBP and DBP values differed significantly between the two groups **(Table 1)**. Before the intervention, all the subjects were told about the purpose of the test, and signed informed consent forms. The study was approved by the Shanghai University of Medicine and Health Sciences' Institutional Review Board for the Protection of Human Subjects.

Study design

According to these criteria, 421 participants from 620 voluntary participants were included for eligibility. According to the study protocol, the eligible participants were randomly divided into a 200-person intervention group and a 221-person control group. The intervention group and control group both included subjects who participated in the GBWT exercise intervention. The GBWT was adopted as the exercise prescription in the intervention group in three phases, totally 24 weeks. In the first phase (8 weeks), the participants were asked to walk for 30 to 35 min daily; their walking speed and strides at the middle point of each walking period, by which point they would have sustained mild fatigue, were measured. The participants walked 2000-4000 m each time, with 4000-6000 steps, 4-5 times per week. In the second phase (16 weeks), the participants were asked to walk for 35-45 min daily. They walked 3500-6000 m each time, with 5000-8000 steps, 4-5 times per week. In the third phase (24 weeks), the participants chose their walking speed according to their capacities; they were asked to walk for 30-50 min daily 4-5 times per week. Before conducting the test, some conditions were prepared for participants: (1) wear comfortable clothes and suitable shoes; (2) can have a small meal before the test if the test were conducted in the morning or afternoon;(3) not doing strenuous exercise within 2 hours before the test, and (4) should not perform warm-up activities before the test;(5) receive routine antihypertensive drug treatment after every day's intervention for the intervention and control groups. The test can be conducted indoor enclosed corridors (or outdoors if the climate is appropriate) on a straight and hard venue not shorter than 20 m. Turn back can be placed with cone-shaped markings, and bright coloured ribbons were located on the starting floor, marking the beginning of each circle. Participants were reminded to promptly signal the researchers to stop the test if emergency situations occur, including but not limited to obvious chest tightness, chest pain, or angina; unbearable difficulty breathing; weakness, difficulty in physical activities, or transient syncope; severe limb muscle pain; obvious tachyarrhythmia; dizziness or headache; largely fluctuating blood pressure (SBP ≥ 240 mmHg and DBP ≥ 130 mmHg); and ataxic gaits, spasm in lower limbs, staggering, sweating, or paleness. The intervention group received routine antihypertensive drug treatment after everyday's intervention. All the participants were provided with light, low-salt, and low-fat meals, and reminded to maintain healthy living habits during the study period, and two or more researchers were guaranteed to take care of the participants and record their blood pressure, heart rate, and breathing rates during the study. The participants' test data and their personal physical feelings during the test were recorded in a timely and accurate manner.

Exercise intensity

According to the Centers for Disease Control and Prevention, we used HR-based method to determine the intensity of the GBWT prescription, with 45%, 60% and 75% of maximum HR obtained by subtracting your age from 220, representing the low, moderate and high intensity exercise levels of the exercise prescription in three time phrases, respectively.

Measurement indicators

The indicators recorded in the test included weight, Body Mass Index (BMI), walking steps, blood pressure, and heart rate. Walking steps and heart rate were measured using a Mi Band 3 (Xiaomi Tech.Co.Ltd., Beijing, CHINA), which was subjected to a 500-step counting test before the test to ensure a measurement error of <5%. The blood pressure indicators, which included SBP (90-140 mmHg) and DBP (60-90 mmHg), were measured using a YE670D smart sphygmomanometer (Yuwell-Jiangsu Yuyue medical equipment and supply Co., Ltd., Zhenjiang, CHINA).

Statistical analysis

All data are expressed as mean ± standard deviation ($\bar{x} \pm s$). A paired samples t-test or the Mann-Whitney U test was conducted before and after the intervention. The count data were compared using the chi-square test. SPSS v21.0 was adapted to process the data and double-tailed P<0.05 indicated statistical significance.

Results

Descriptive analysis

200, 190 and 170 participants in the intervention group were analyzed during the first, second, and third phases, respectively. No participants in the control group withdrew from the test over three phases. Subjects flow throughout the study process, including reasons for withdrawal, is shown in **Figure 1**. The control group comprised 134 men and 87 women with an average age of 65.30 ± 9.10 years, an average BMI of 25.22 ± 0.20 kg/m², and an average HR of 73.44 ± 6.80 Beats/m and an average SBP/DBP of 118.21 ± 14.29/75.13 ± 6.14 mmHg. The intervention group comprised 121 men and 79 women with an average age of 65.90 ± 7.60 years, an average BMI of 26.67 ± 0.70 kg/m², an average HR of 82.50 ± 7.40 Beats/m and an average SBP/DBP of 148.23 ± 12.50/97.05 ± 7.47 mmHg. No differences were observed between the intervention group and control groups for each of these parameters except of blood pressure, more details can be seen in **Table 1**.

Effect of the intervention on outcome variables

BMI: An ANOVA with repeated measures on time resulted in no significant time main effect, condition main effect, or time by condition interaction.

HR: Similarly, An ANOVA showed that there was no significant time main effect, condition main effect, or time by condition interaction in HR indicators.

Blood pressure: Overall effect: As a whole, as SBP and DBP are likely to be related, a two-way ANOVA was conducted to test if there was a condition effect on SBP and DBP over time. The ANOVA revealed significant condition main effects, time by condition interaction or time main effects (F=21.875,33.457,65.342, respectively, all P<0.05) with SBP decreasing from the baseline (148.23 ± 12.50) to 8-week (135.27 ± 1.78), 16-week (133.44 ± 10.19) and 24-week post-intervention (140.23 ± 9.55), DBP decreasing from the baseline (97.05 ± 7.47) to 8-week (89.14 ± 6.57), 16-week (88.58 ± 7.66)and 24-week post-intervention (93.97 ± 7.17)in the intervention group. It indicated significant variations of SBP and DBP between two groups at three time points, and they were both affected by the condition over time **(Table 2)**.

Between-group comparison: A unidirectional ANOVA showed that after the intervention, there showed significant differences both in SBP and DBP values for two groups (all P<0.05), and average values of the intervention group were significantly lower than those of the control group from baseline to the second phase (all P<0.05) with exception of the third phase (24-week intervention) (P>0.05). Moreover, the SBP and DBP values also decreased by significantly faster than those of the control group at the aforementioned time points (at 8-week and 16-week phase) **(Figure 1)**.

Table 1: General data analysis of the participants before the intervention.

Variable	Control Group (n = 221) `x ± s	Intervention Group (n = 200) `x ± s	P-Value
Age (years)	65.30 ± 9.10	65.90 ± 7.60	0.78*
Gender (%male)	66.6	66.6	1.00*
BMI (kg/m²)	25.22 ± 0.20	26.67 ± 0.70	0.56*
HR (Beats/minute)	73.34 ± 6.80	82.50 ± 7.40	0.14*
SBP (mmHg)	118.21 ± 14.29	148.23 ± 12.50	0.01*
DBP (mmHg)	75.13 ± 6.14	97.05 ± 7.47	0.01*

Notes: BMI: Body Mass Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure;* Two-samples t test between the intervention group and the control group.

Table 2: Changes in test indicators in the two groups before and after the intervention ($\bar{x} \pm s$).

Indicators	Baseline	8 weeks (phase 1)	16 weeks (phase 2)	24 weeks (phase 3)
BMI				
Control Group	23.22 ± 0.20	23.52 ± 0.32	23.69 ± 0.23	23.65 ± 0.19
Intervention Group	26.67 ± 0.70	23.15 ± 0.40	22.07 ± 0.60	25.93 ± 0.70
SBP				
Control Group	118.21 ± 14.29	115.26 ± 12.13	113.34 ± 12.16	112.14 ± 13.26
Intervention Group	148.23 ± 12.50	135.27 ± 1.78	133.44 ± 10.19	140.23 ± 9.55
DBP				
Control Group	75.13 ± 6.14	73.16 ± 7.16	70.13 ± 5.13	70.21 ± 5.68
Intervention Group	97.05 ± 7.47	89.14 ± 6.57	88.58 ± 7.66	93.97 ± 7.17
HR				
Control Group	73.34 ± 6.80	78.42 ± 6.34	76.49 ± 6.53	76.23 ± 6.76
Intervention Group	82.50 ± 7.40	80.30 ± 6.20	76.92 ± 7.10	77.80 ± 5.80

Notes: BMI: Body Mass Index; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; aP<0.05 (compared to the BP in the same group before intervention); bP<0.05 (compared to BP after the first time point (8 weeks in) the same group).

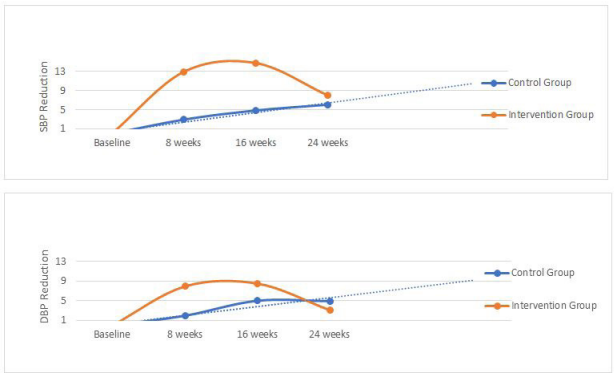

Figure 1: The comparison in BP reduction for two groups from baseline to 24-week GBWT exercise.

Within-group comparison: A one-way ANOVA with repeated measures resulted in significant differences in the blood pressure values after the first two phases compared with those before the intervention. Similarly, using a paired samples t-test, there was a significant difference between the first phase (8 weeks, low-intensity exercise) and the second phase (16 weeks, moderate-intensity exercise) in the intervention group. However, after the third phase (24 weeks, high-intensity exercise), no significant differences were found both in SBP and DBP values compared with those before the intervention (P=0.07). Similarly, the paired samples t-test also revealed no significant decrease between the second phase and the third phase.

Discussion

This study researched the effect of the GBWT of exercise on blood pressure in patients with essential hypertension. Our results indicated that 8 and 16 weeks of low-moderate intensity exercise reduce significantly SBP, DBP in different phases of exercises. However, 24 weeks of high intensity exercise had no significant reduction effect but clinical effectiveness in BP of patients with essential hypertension.

The existing literature has shown that 4 to 12 weeks of aerobic exercise could lower resting SBP in patients with essential hypertension by 5 to 15 mmHg; and resting DBP by 4 to 9 mmHg [12]. In this present study, after the first and second phases, the decrease levels of SBP and DBP in the intervention group were 12.96 to 14.79 and 7.91 to 8.47 mmHg, respectively, lower than those in the control group. Some studies have shown that proper intensity of exercise can reduce the endothelin which has strong vaso-constrictive effect. Furthermore, it was also found that the sharp drop of blood pressure after exercise was related to the decrease of peripheral resistance caused by the relaxation of smooth muscle of systemic arterioles, and many studies have found that the systemic and local peripheral vascular resistance will decrease after exercise than before [13]. Additionally, many previous studies reported that the mid and moderate intensity of walking exercises could reduce blood pressure (SBP or DBP) in the older population with hypertension in Chinese communities [9,14-22]. According to international clinical effect evaluation standards, the effectiveness of this blood pressure control method has clinical significance. Therefore, low and moderate-intensity GBWT is effective in reducing and controlling the blood pressure of patients with essential hypertension.

However, high-intensity GBWT did not significantly reduce the blood pressure of the participants in the present study. This finding seemed to be opposite to the results of some previous the factor of age when conducting exercise interventions to lower blood pressure for older hypertensive individuals in Chinese communities.

Conclusion

In conclusion, the GBWT is effective as an exercise prescription for mitigating essential hypertension in Chinese elderly patients. Moreover, the intensity, walking distance, and target number of steps can be adjusted according to the age of the patients, thus enhancing the accessibility and operability of exercise therapy and facilitating promotion in Chinese communities for essential hypertension control and prevention.

Limitations

Several limitations should be mentioned. Firstly, we conducted a restricted data collecting from a Chinese community through a primary health center. Sampling size may affect generalizing some findings of this study. Secondly, although baseline medications were no difference between the two groups, changes in doses were not recorded, probably potentially confounding observed results.

Additional file 1: **Figure 1**: the comparison in BP reduction for two groups from baseline to 24-week GBWT exercise.

Declarations

Acknowledgements

Not applicable.

Ethical approval and consent to participate

All procedures involving human participants were reviewed and approved by the Shanghai University of Medicine and Health Sciences' Institutional Review Board for the Protection of Human Subjects.

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