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Decrease in blood pressure and improved psychological aspects through meditation training in hypertensive older adults: A randomized control study

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Aim: The present study aimed to evaluate the effects of Zen meditation on blood pressure (BP) and quality of life in elderly subjects.

Methods: A total of 59 volunteers (21 men and 38 women), aged ≥60 years with systolic BP between 130 and 159 mmHg and diastolic BP between 85 and 99 mmHg, were randomly divided into a meditation group (MG), $n = 28$ and a control group (CG), $n = 31$. The MG meditated twice a day for 20 min for 3 months, and the CG remained on a waiting list. The BP levels were measured monthly in both groups. The volunteers' medication was kept stable. A quality of life assessment instrument was applied at the beginning and end of the study.

Results: For systolic BP, analysis of variance showed the influence of time ($F_{(4,228)} = 4.74$, $P < 0.01$, $\beta = 0.98$) and the interaction group × time ($F_{(4,228)} = 3.07$, $P < 0.01$, $\beta = 0.89$). The MG showed a significant decrease in systolic BP levels in the second measurement after 1 month of meditation practice when compared with the CG (Newman–Keuls test, $P < 0.05$). Starting at the second measurement, systolic BP levels in the MG were lower than the baseline and first measurement levels; however, the systolic BP levels were similar to those observed in the CG. In the quality of life assessment evaluation, a significant improvement in psychological aspects and overall quality of life in the MG compared with the CG was observed.

Conclusion: These results suggest that Zen meditation is an interesting tool as a complementary treatment for hypertension in elderly subjects. **Geriatr Gerontol Int 2014; ••: ••–••.**

Keywords: elderly, hypertension, meditation, quality of life.

Introduction

Arterial hypertension (AH) is the main risk factor for cardiovascular disease, which is responsible for the deaths of 17.3 million people annually.[1] AH involves a complex interaction of factors, including age and lifestyle.[2] This condition is highly prevalent among older people,[3,4] owing to its association with vascular aging.[5] As a result, the aging population is more vulnerable to fatal and non-fatal strokes, with consequent sequelae and impairment in the quality of life of individuals and their families.[6] Considering the aging of the population, hypertension will likely have a major economic impact in coming decades.[7]

Despite available antihypertensive drug therapy, the blood pressure (BP) of most hypertensive individuals is not controlled, primarily because of poor adherence to treatment.[8–10] In particular, complaints about adverse treatment effects, mainly associated with other drugs of continuous use, are common among the elderly.[8] Furthermore, poor management of treatment is responsible for the occurrence of additional health problems and the high costs incurred to the health system.[11] Non-pharmacological approaches, including health education and the promotion of healthy habits, are essential elements for the treatment and prevention of AH.[12] For

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example, the practice of yoga among elderly subjects at risk for cardiovascular disease has been shown to improve physical function, mental and emotional states, and lifestyle choices, which are important elements for the management of chronic diseases.[13] Meditation as a technique for stress management can also help prevent or delay the onset of hypertension, and reduce BP levels in hypertensive individuals.[4,7,14] In particular, clinical studies have shown peripheral vasodilation during meditation, which could explain the benefits of decreased BP levels.[15] Furthermore, these benefits might be more effective and lasting when compared with other strategies, such as health education and progressive muscle relaxation.[16] A study comparing yoga, pranayama and amrita meditation techniques revealed the effects of meditation on stress hormones, showing a decrease in the levels of adrenaline and cortisol.[17]

During Zen meditation, the novice practitioner can practice counting their breaths to focus their attention and avoid scattered thoughts. With advancing practice, counting the breaths becomes unnecessary, and practitioners simply focus their awareness in the present moment; this is called Shikantaza, and is a more advanced form of Zen meditation.[18] This practice modulates heart rate variability by decreasing the respiratory rate.[19] Zen meditation is a technique that requires few resources to be implemented, is low cost, and has no known side-effects; however, its benefits for the elderly have not been fully elucidated. Therefore, the present study aimed to evaluate the effects of this technique on the control of BP and quality of life in hypertensive elderly subjects.

Methods

The study protocol was approved by the Research Ethics Committee of the Universidade Federal de São Paulo, and all participants read and signed an informed consent form. The study was carried out in the Department of Psychobiology at the same University.

Volunteers aged >60 years were recruited through media advertising. The volunteers who did not practice any form of meditation and who had ≥4 years of formal school education were eligible to enrol in the study. The volunteers' BP levels had meet the following criteria: systolic pressure between 130 and 159 mmHg, and diastolic pressure between 85 and 99 mmHg (considered the upper and lower-limit BP levels for mild hypertension stage I), as established by the European Society of Hypertension.[12] Volunteers could be undergoing treatment with antihypertensive drugs as long as the dose was stable for at least 3 months and remained stable until the end of the study.

Exclusion criteria included the presence of disabling diseases, such as severe heart disease, kidney failure, and secondary hypertension; illicit drug use and alcohol abuse; psychiatric disorders; and severe cognitive impairment, among others. During the study period, participants were excluded if their BP level exceeded the established limits and showed clinical evidence of risk to the patient, if the dose of antihypertensive drugs was changed or the participants used medications known to interfere with BP, including anti-inflammatory and anorectic drugs, and if those belonging to the meditation group (MG) had three consecutive absences. Participants had to maintain regular eating habits, physical activity and sleep patterns.

Of the 347 volunteers who responded to the study advertisement, 65 were selected for the study after rigorous screening and medical evaluation, and were randomly distributed into the MG and the control group (CG). Participants underwent a structured interview carried out by the team psychologist. In addition, all participants underwent a medical evaluation involving the following laboratory tests: complete blood count; fasting blood glucose; measurement of thyroid-stimulating hormone, T3, total and free T4, urea, and creatinine concentrations; and urinalysis. As part of the cognitive assessment, the Mini-Mental State Examination (MMSE) was applied.[20,21] Blood pressure measurements were obtained using a calibrated digital automatic device, model BP 3AC1-1 (Microlife, Clearwater, FL, USA). Measurements were carried out from the left arm after the participant was placed in a seated position and had rested for ≥5 min. For increased accuracy, the mean of three successive measurements was used in the analyses. BP was measured monthly in both groups. After 3 months of study, an initial measurement (baseline value) and a series of four other monthly measurements were evaluated during the experimental phase.

At the beginning and end of the experiment, the World Health Organization Quality of Life assessment instrument (WHOQOL-100) was applied.[22] This instrument consists of 100 questions from six domains, including physical, psychological, level of independence, social relationships, environment and spirituality/religion/personal beliefs. The six domains branch into 24 subdomains (facets), and one additional facet corresponding to overall quality of life. Each facet is comprised of four self-evaluation questions about the perception of quality of life.

Participants from the MG received a diary to record the frequency of meditation practice and other relevant observations.

The 3-month Zen meditation program adapted for beginners consisted of weekly 1-h group meetings and daily home meditation practices. The practitioners must remain in a seated position for 20 min, with the spine straight, shoulders relaxed, hands resting on the thighs, eyes closed and mentally counting the breaths in successive cycles of one to 10, for 20 min. During meditation, the focus should be kept on breathing in the

present moment. The participants were encouraged to let their thoughts flow without attachment, judgment or criticism, without disturbances from any internal or external factors. Participants were instructed to practice the method at home twice a day, and to resume the relaxation achieved throughout the day. A member of the research team and an invited monk from the Zen Buddhist tradition instructed and monitored the weekly meditation practice.

The participants in the CG remained on a waiting list throughout the experimental period and, for ethical reasons, received the same meditation training at the end of the experiment.

Numerical variables were analyzed according to the kind of data distribution. In order to compare two groups, we used Wilcoxon and Mann–Whitney tests when the distribution was not normal, or one and two-way ANOVA when the distribution was normal and the variances homogeneous. When significant effects were detected by one and two-way ANOVA, post-hoc analyses were carried out with Scheffé and Newman–Keuls tests. The significance level was set at 5% in all analyses. Statistical analyses were carried out using the software Statistica 8.0. The graphs were generated using GraphPad Prism version 5. Analysis of systolic and diastolic BP, and pulse rate data was carried out using analysis of variance for repeated measures (MANIVA). Factor group (MG and CG) was considered the independent variable, and BP and pulse rate measurements were considered dependent variables.

The frequency of meditation practice was analyzed by using the Wilcoxon test for two dependent samples, considering the first and last month of meditation practice. For WHOQOL-100 analysis, we used a Mann–Whitney test to evaluate possible differences between the two groups for the variables of interest.

Results

Six volunteers were excluded from the study because of changes in their antihypertensive medication or lack of adherence to the meditation program. One male participant did not correctly fill out the WHOQOL questionnaire, and his data were therefore excluded from the analysis. As a result, 59 volunteers participated in the analysis of BP, including 31 CG volunteers (11 men and 20 women) and 28 MG volunteers (10 men and 18 women), as well as 58 volunteers for the WHOQOL analyses.

In the CG, the age (mean ± SD) was 67.0 ± 5.6 years, and in the MG was 67.2 ± 4.6 years. In the CG, 74.2% of the participants had received higher education, and this level in the MG was 67.3%. No significant differences were observed between the groups regarding the level of education, smoking history, alcohol consumption and body mass index (BMI). The mean BMI values were 28.8 ± 4.04 kg/m^2 and 29 ± 4.18 kg/m^2 in the CG and MG, respectively.

Table 1 Antihypertensive drugs used on each group

Antihypertensive drug	CG (n)	MG (*n*)
Amiloride	2	6
Amlodipine	2	3
Atenolol	8	3
Captopril	3	0
Clortalidone	3	4
Diltiazem	1	0
Enalapril	4	2
Hydrochlorothiazide	7	10
Lisinopril	0	1
Losartan	5	6
Metropolol	2	1
Nifedipine	0	2
Propanolol	0	1
Valsartan	1	4

Most participants were using one substance or more. CG, control group; MG, meditation group.

During the preliminary measurements for the selection of volunteers, no differences were observed between the two groups regarding the levels of systolic and diastolic BP and pulse rate. All MG participants used antihypertensive drugs, and in the CG two participants with excessive BP levels were not using medication, at the physician's discretion (Table 1). These conditions were maintained throughout the experiment.

Figure 1 shows the effects of meditation practice on the levels of systolic and diastolic BP, and pulse rate in the MG relative to the baseline (initial pressure) levels and during meditation, as compared with the levels in the CG. In the MG, measurement 1 refers to the first day of training.

In relation to systolic BP (Fig. 1a), ANOVA indicated significance for the influence of factor time ($F_{(4,228)}$ = 4.74, $P < 0.01$, $\beta = 0.98$) and the interaction groups × time ($F_{(4,228)} = 3.07$, $P < 0.01$, $\beta = 0.89$). Participants from the MG showed lower systolic BP values in the second measurement compared with the CG (Newman–Keuls test, $P < 0.05$). Starting from the second measurement, systolic BP levels in the MG were different from the initial BP levels and those obtained in the first measurement; however, they were similar to those of the CG. With regard to diastolic BP (Fig. 1b), a significant effect of time was observed ($F_{(4,228)} = 3.23$, $P < 0.05$, $\beta = 0.87$), and the values obtained in the second measurement were lower than those obtained at baseline and in the first measurement. With regard to pulse rate, a significant effect was observed only for time ($F_{(4,228)} = 3.09$, $P < 0.05$, β 0.99), and the values of the third

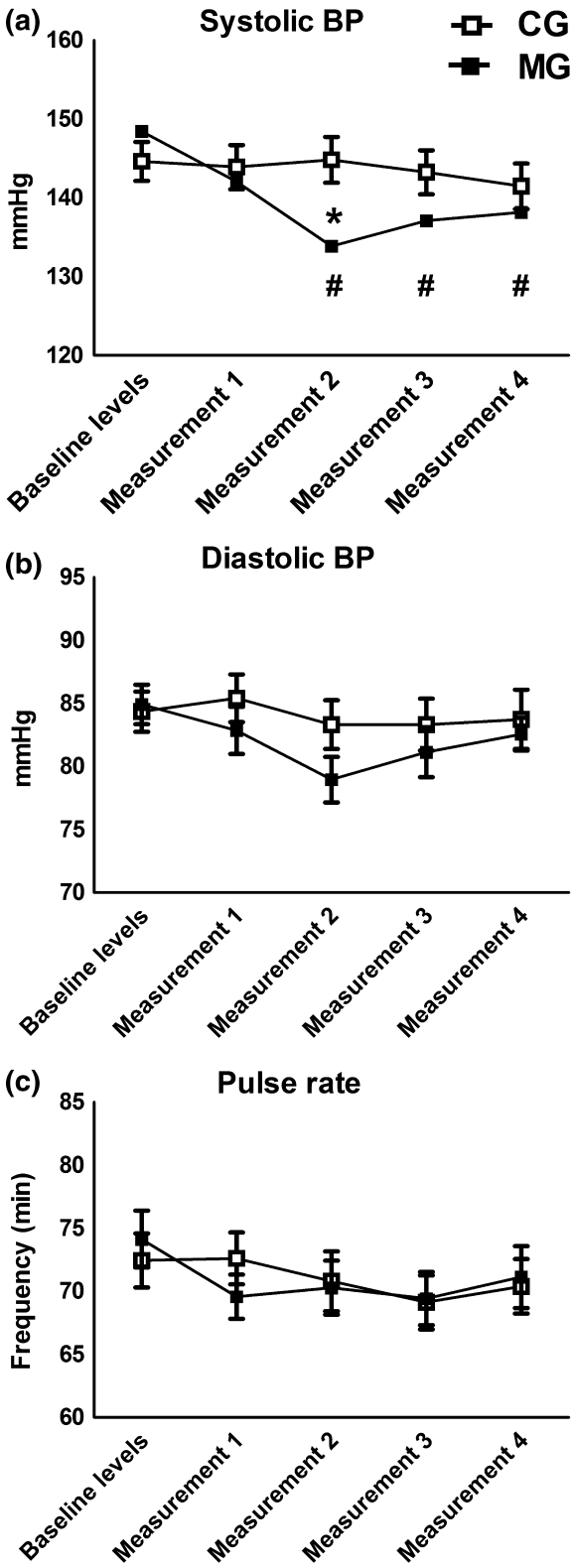

Figure 1 (a) Systolic blood pressure in mmHg (mean ± standard error) in the meditation group (MG; $n = 28$) and control group (CG; $n = 31$) according to baseline and the four monthly measurements carried out starting on the first day of meditation practice. (b) Diastolic blood pressure in mmHg (mean ± standard error) in the same groups. (c) Pulse rates in the same participants. *Significantly different from the control group ($P < 0.05$). #The levels in the MG differ significantly from baseline and those obtained in the first measurement ($P < 0.05$).

measurement were lower than those of the fourth measurement (Newman–Keuls test, $P < 0.05$).

When the frequency of meditation practice in the first and last month of practice (considering the number of sessions carried out in each month) was analyzed, the frequency of practice in the last month was significantly lower than that in the first month ($Z = 2.75$, $P < 0.05$).

In the WHOQOL-100 analysis, no differences in quality of life were observed between groups during the preliminary assessment. However, after the intervention, significant differences were found for some WHOQOL-100 facets in the MG when compared with the CG. In particular, the MG showed higher scores compared with those in the CG in facets 5 (thinking, learning, memory and concentration), 6 (self-esteem), 20 (opportunity to acquire new information and skills) and 25 (overall quality of life and overall health perception).

Table 2 shows the descriptive statistics of the WHOQOL-100 facet scores in which significant differences were found between the MG and CG at the end of 3 months.

Higher scores were observed in the MG for facets 5, 6, 20 and 25 when compared with the CG, showing potential beneficial effects of meditation training.

Discussion

The practice of Zen meditation adjusted for novice practitioners decreased systolic BP levels and improved the perception of certain aspects of quality of life in our group of elderly subjects. In addition, the decrease of systolic BP levels in the MG was observed after 1 month of practice, during the second measurement. In the MG, these levels remained lower than the baseline and first measurement levels, suggesting a sustained decrease of BP levels. Regarding diastolic BP and pulse rate, no significant differences were observed between the two groups.

Based on the WHOQOL-100 data, we observed that meditation practice promoted beneficial effects on the perception of certain aspects of the psychological domain, with better results associated with thinking, learning, memory, concentration and self-esteem in MG. Furthermore, benefits were observed in the ability

Table 2 World Health Organization Quality of Life assessment instrument facets in which significant differences were observed between the meditation group and control group post-intervention

WHOQOL 100	Groups	*n*	Mean	SD	25th Percentile.	50th Percentile. (median)	75th Percentile.	*P*
Domain II: Psychological	CG	31	63.1	14.7	50.0	62.5	75.0	**0.035**
Facet 5: thinking, learning, memory, concentration	MG	27	71.3	11.0	62.5	75.0	75.0	
Domain II: Psychological	CG	31	66.9	17.7	56.2	75.0	75.0	**0.046**
Facet 6: self-esteem	MG	27	76.8	10.3	68.7	75.0	81.2	
Domain V: Environment	CG	31	69.7	13.2	62.5	75.0	75.0	**0.021**
Facet 20: opportunity to acquire new information and skills	MG	27	77.7	17.7	68.7	81.2	93.7	
Facet 25: overall quality of life and overall health perception	CG	31	67.3	14.8	56.2	68.7	75.0	**0.003**
	MG	27	78.0	14.1	75.0	75.0	93.7	

The other facets did not present significant differences. CG, control group; MG, meditation group.

to acquire new information and skills; in the elderly, these beneficial effects have been shown to help manage overall treatment.[11] The MG experienced improvements in overall health perception and overall quality of life, even in the absence of changes in diet, exercise and use of medications.

Based on the meditation diary used in the present study, a trend towards poor adherence to medical treatment over time was detected.[23] These data might reflect what happens in routine primary care; that is, the tendency to disregard medical recommendations over time and even abandon treatment.[10,11] Part of the success of treatment depends on the patient, and on their decision to adopt healthy behaviors and new lifestyles.[24,25] Indeed, reluctance in accepting proposed medical treatments can become a barrier and prevent individuals from enjoying the full range of medical benefits associated with BP control.[24] Hypertensive subjects have also been shown to require constant stimulus to change their lifestyle and adjust to treatment.[9,11] In regard to meditation, it is known that those who practice meditation more often will have better health outcomes.[26] However, other factors including personality traits,[27] personal experience, expectation, motivation and values can influence adhesion to practice, and interfere with the effectiveness of treatment.[17]

Meditation is a practice of self-regulation of the body and mind.[28] In particular, the focus on the present moment rather than internal and external distractions, and the practice of non-judgment, acceptance and kindness are characteristics of Zen meditation that contribute to positive mental states, and increase the awareness of a new, more flexible and appropriate way of perceiving reality that is associated with the perception of well-being.[18,28,29]

The results of systolic BP obtained in the present study show the benefits of meditation for elderly practitioners, even in the presence of AH, which is a complex condition involving a variety of vessel and artery mechanisms, tissues (heart, kidneys and lungs), systems (e.g. cardiovascular, circulatory and central nervous system), and psychological and environmental factors.[2] Furthermore, changes in the circulatory system, including artery stiffness, endothelial dysfunction, increased sensitivity to sodium, changes in baroreceptor sensitivity and others, make hypertension more difficult to control in the elderly.[4,5]

The effects of meditation involve several mechanisms, including physiological and hormonal changes that can be observed after 8 days of intensive practice. These changes also illustrate the interaction between meditation practice and the activation of brain areas related to the relaxation response, which involves changes in the tone of the autonomic nervous system, and increased parasympathetic activity associated with low heart and respiratory rates.[30–32] In studies using electroencephalography, researchers observed increased activity in frontal midline theta waves during meditation, and this increase was correlated with cardiac activity.[33] In addition, a significant decrease in adrenaline levels was observed as immediate and long-term effects of meditation, and this result was associated with the decrease in both BP levels and sympathetic nervous system tone.[17] Another mechanism responsible for decreased BP levels during meditation could be related to the decrease in total peripheral resistance, suggesting that the decrease in blood vessel tone might be the hemodynamic mechanism responsible for the decrease in BP over time.[15] Considering the low breathing rate observed during meditation, heart rate synchronization capable of modulating heart rate variability and controlling other cardiovascular parameters; for example, baroreceptor sensitivity, has been observed to modify BP levels.[34]

Previous examination of the molecular processes involved in meditation practice showed that central and peripheral mechanisms induced the synthesis and release of noradrenaline, nitric oxide, dopamine, and endogenous opioids acting at various levels both in the central nervous system and peripheral system, resulting in decreased heart rate, vasodilation, thermal heating and in the case of opioids, a sense of well-being involving the reward system.[35] In particular, nitric oxide plays a prominent role in vasodilation, which affects BP levels, and is also involved in other cardiovascular processes related to the relaxation response evoked by meditation.[32,36] However, the present study shows some limitations once participants took different classes, combinations and doses of antihypertensive drugs with different mechanisms of action to lower blood pressure. Therefore, treatment standardization was not achieved.

In summary, complementary medical treatment adopting Zen meditation techniques decreased systolic BP and improved some quality of life aspects, despite the fact that the elderly subjects had been under medical treatment during the study. Zen meditation adapted for novice practitioners is a simple, non-invasive technique that is easy to implement at a low cost. Therefore, this approach should be encouraged as a complementary therapy in the treatment of hypertension among the elderly.

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Disclosure statement

The authors declare no conflicts of interest related to the study and preparation of this manuscript.

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