An Audio Relaxation Tool for Blood Pressure Reduction in Older Adults

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The purpose of this pilot study was to evaluate the effectiveness of an audio relaxation tool for lowering blood pressure and augmenting heart rate variability (HRV) in older adults. Fourteen older adults (83 ± 8 years) participated in the study. The intervention consisted of 12 sessions of a guided relaxation program. Blood pressure was taken before and after each intervention. HRV was assessed once before training and at the conclusion of the final session. Paired sample *t* tests were used for data analysis. Comparing pre and post parameters for all sessions, the intervention resulted in a statistically significant reduction in systolic blood pressure ($P < .001$), diastolic blood pressure ($P < .001$), and heart rate ($P < .005$). HRV was unaffected. This study provides support for the use of guided relaxation to reduce high blood pressure in older adults. This 12-minute relaxation audio program can be used for high blood pressure prevention or in conjunction with antihypertensive medications for blood pressure management. Further research is recommended. (*Geriatr Nurs* 2008;29:392-401)

The purpose of this study was to examine the effectiveness of a 12-minute audio-guided relaxation program for blood pressure reduction and heart rate variability augmentation in older adults.

Guided relaxation is a nursing intervention used by health professionals in clinical practice to assist clients in achieving an equilibrium state of physiological-psychosocial-spiritual being. The foundation of guided relaxation is based on the model of self-regulation and the mind-body connection.[1,2] With verbal instruction, individuals learn to reframe the psychological appraisal mentally while physically practicing abdominal breathing to augment stress-related physiological parameters such as blood pressure and heart rate.[3,4] The use of guided relaxation has been studied in cancer patients for chemotherapy-induced side effects,[5,6] in osteoporosis patients for chronic pain management,[7] in surgical patients for anxiety and pain control,[8,9] and in anxiety or obsessive-compulsive disorders[10] to reduce hyperarousal. Notably, few studies have documented the use of audio-guided relaxation for the management of hypertension, a common chronic pathophysiological state, especially in older adult population.

Background

Hypertension and the Autonomic Nervous System

Uncontrolled hypertension often results in serious health consequences, such as cardiovascular disease and stroke, which ultimately increase medical demand and cost. Elevated blood pressure is caused by dysregulation of the autonomic and endocrine systems or by dysregulation secondary to psychological arousal. An increase in sympathetic stimulation not only directly increases blood pressure but can also increase baroreceptor sensitivity due to the increased sympathetic tone. The increase in sympathetic tone results in hypertension and a decrease in heart rate variability.

Heart Rate Variability

Heart rate variability (HRV) has been studied as an indicator for overall heart health. The frequency of HRV, measured in Hertz, depicts the quality of balance within the autonomic nervous system. The link between hypertension and HRV was noted nearly 2 decades ago,[11,12] with continued evidence supporting the theory that the imbalance of sympathovagal function and sympathetic predominance may result in chronic hypertension.[13-15] HRV mathematically analyzes the beat-to-beat fluctuation of the heart rate (known as the *time domain*) and the amplitude of the heart rate measured in Hertz (known as the *frequency domain*) to assess the overall balance of the autonomic nervous system (ANS). In this mathematical analysis, very low and high frequencies represent PNS (parasympathetic nervous system) activity, low frequency represents SNS (sympathetic nervous system), and the ratio of low to high frequency represents ANS balance.[16] The frequency domain of HRV is a measurement used primarily in research. The goal for a healthy heart is to have an effective balance, that is, to have variability in heart rate. A person, for example, may need to increase HRV to compensate for increased physiological demands of physical activity. In short, heart rate must be flexible to respond to a person's activity level. People must maintain variability of heart rate as they age, because there is a natural attrition in HRV with age.[17-22] In addition, a positive association has been found between mortality and very low frequency, or low variability.[23-25] HRV was also found to decrease considerably after sudden cardiac arrest and acute myocardial infarction, and gradually regain the balance within 6 months of recovery.[26] Although the exact mechanism of age-related HRV reduction remains unknown, significant data support the hypothesis of age-related reduction of postsynaptic adrenergic responsiveness[27,28] and the alteration in sinus node function,[29,30] which results in parasympathetic functional decline.[31] Further detail on HRV measurement is discussed in the Methods section. The focus of this study was to examine changes in blood pressure and HRV after a relaxation intervention.

Hypertension in Older Adults

In a report from the Centers for Disease Control and Prevention (CDC), hypertension was identified as the primary cause of death in more than a quarter million Americans in 2002. Medical costs of high blood pressure were estimated at $63.5 billion for the year 2006.[32,33] Similar to, and perhaps related to, the decrease in HRV, the prevalence and severity of hypertension tend to increase with age. The CDC reported that the hypertension rate in the 55- to 64-year-old age group in the United States is 50%,[34] and this increases to 60%-80% for ages 65 and older.[35-37] Studies have shown an age-related linear rise in systolic blood pressure and a linear reduction in diastolic blood pressure after age 50-60 years.[38,39] Isolated systolic hypertension accounts for 65%-75% of hypertension in older adults.[40] The population of individuals aged 65 and older is the group that has the lowest rate of blood pressure control.[41] Uncontrolled hypertension often causes serious health consequences such as cardiovascular disease or stroke. Standard treatment of hypertension includes medications that are inhibitors of the sympathetic nervous system as well as modifiers of endocrine activity. Importantly, given the multifactorial causes of hypertension, it has been suggested that antihypertensive medication should be augmented by lifestyle changes such as diet, exercise, weight control, and stress management.[42] Relaxation training is one approach that promotes stress reduction, and it may help to decrease the use of multiple medications.

Alternative Therapies for Hypertension

Although regular exercise is the most commonly recommended adjunctive therapy for hypertension management,[43] other approaches such as guided imagery,[44,45] progressive muscle relaxation, biofeedback,[46-48] abdominal breathing,[49,50] and music relaxation[51] have been used to manage psychological arousal for cardiovascular augmentation (reduce blood pressure and heart rate; increase HRV) and for anxiety reduction or pain control in various settings such as preoperative, postoperative, and critical care.[52,53]

Most of these techniques are based on the mind-body model that involves complex biochemical reactions at the cellular level of major organ systems through the autonomic nervous system.[54] The intervention of audio-guided relaxation in this study used 2 main concepts of the mind-body model:

1. *Mind modulation of the autonomic nervous system:* Psychological appraisal links to the hypothalamic-limbic system, which determines the secretion of neurotransmitters to stimulate either sympathetic (activating-norepinephrine) or parasympathetic (relaxing-acetylcholine) responses.[54,55]
2. *Baroreflex stimulation in cardiac autonomic regulation:* Slow and steady breathing patterns (6-10 breaths/min) increases baroreflex sensitivity and reduces sympathetic activity and chemoreflex activation, resulting in decreased blood pressure and increased HRV.[3,50,56-58]

Although the literature supports the effectiveness of relaxation techniques in cardiac augmentation, few studies have explored its use in an older adult population in a community setting.

Methods

Design

A descriptive pilot study was designed to evaluate the effectiveness of an audio relaxation tool for lowering blood pressure and for augmenting HRV in older adults. This study used a single-group pretest-posttest design with 12 separate data collection points. The goal was to identify whether this intervention would change blood pressure or HRV outcomes.

Sample

Convenience sampling was used for this pilot study. Recruitment flyers were posted on the bulletin board of an independent retirement living facility. An information session was provided to the residents at a monthly community meeting. Participants signed up for the study on a voluntary basis. The inclusion criteria consisted of age 65 or older, English-speaking, normal hearing with or without the hearing aids, and Mini-Mental Status Examination (MMSE) score ≥20. The cut point of 20 on MMSE for this study was based on the recommended norm score for individual age 80-84 with fourth-grade level of education.[59] Body mass index and cardiac medications were assessed to help characterize major factors of cardiac health[60] within the sample group but were not part of the inclusion criteria. Blood pressure parameters were not included in the inclusion criteria for this pilot study.

Seventeen of 109 residents responded to the call for participants. All were screened for meeting the inclusion criteria, and all respondents met the criteria. All 17 respondents were recruited into the study. Three participants withdrew part way through the study because of illness, leaving a sample size of 14 participants.

Permission to conduct this study was obtained from a retirement living facility on the West Coast of United States. The proposal was approved by the facility administrator, the residence committee, and the Human Subjects Committee of Seattle University. The data collection period covers 2 months during the summer of 2006.

Setting

This study was conducted at the residential living center in a quiet conference room with individual stereo CD players and headphones. Participants were encouraged to rest in a comfortable sitting position at the start of the intervention. All measurements in this study were conducted in the same quiet and private conference room on-site where the environment was familiar to the participants.

Intervention

The intervention consists of 12 sessions of a 12-minute guided-relaxation audio program, conducted 3 times a week for 4 weeks. The 12-minute audio soundtracks featured left/right whisper tracks, a center track of verbal instruction, a soothing ocean background, and a binaural tone to facilitate deep relaxation. The center track provides instruction with the focus on cognitive reformation, muscle relaxation, and breathing technique.[61]

The session started by having the participants sit comfortably for 5 minutes without disturbance to acclimate to the environment. Preintervention blood pressure was then measured followed by a 12-minute audio-guided relaxation intervention. At the end of each relaxation program, blood pressure was measured again. HRV was measured once at the beginning of the study and once again at the end of 12th session of intervention.

Measures

Physiological data were gathered to evaluate the effectiveness of the intervention. The data collector is a doctorally prepared registered nurse with nine years of clinical experiences. The measured physiological data included blood pressure, heart rate, and heart rate variability.

Blood pressure

Systolic pressure, diastolic pressure, and mean heart rate were measured using a medical-grade automatic blood pressure device that was newly purchased for the study. The electronic blood pressure machine was compared with a manual aneroid sphygmomanometer for its concurrent validity ($r = 0.95$). Blood pressure was taken before and after each intervention session with the participants in a sitting position. Preintervention blood pressure was measured after the participant had been sitting quietly for 5 minutes, and all blood pressures were measured in the same arm with appropriate cuff size each time for each individual. A log was kept for the consistency of measurement.

Heart rate variability

Five minutes of HRV was measured once before the intervention and at the conclusion of the final session using the BioComp Program.[62] Data were collected through a noninvasive approach with sensors on the index finger of each hand while the participant was in a resting sitting position.

Both time domain and frequency domain measures of HRV were gathered. Time domain variables included heart rate, standard deviation of normal-to-normal heart beat (NN) intervals (SDNN), and the square root of the mean squared differences of successive NN intervals (RMS-SD). These values are recognized to be less accurate in 5-minute measurements.[16,63] Frequency domain variables included total power, very-low-frequency (VLF), low-frequency (LF), high-frequency (HF), and low- and high-frequency ratio (LF/HF ratio). Content validity of the BioComp program was performed by a bioengineer who is an expert in HRV measurement. Internal consistency (r = 0.71-0.73) and test-retest reliability (r = 0.82-0.84) of the BioComp program were obtained from a previous study with similar population.[64]

Related data

Demographic data such as age, gender, ethnicity, and marital status, along with medical data such as medication list, height, and weight, were obtained from the medical record at the health center where participants reside.

Data Analysis

Data were entered and analyzed in Statistical Package for the Social Sciences (SPSS). Descriptive statistics were used to obtain demographic information of the studied population. Paired samples t test was used to examine the pre- and postintervention difference in blood pressure and HRV. Percentage change was used to explore the individual difference of changes in blood pressures.

Results

Sample Characteristics

Fourteen participants (83 ± 8 years; 1 man, 13 women) completed the study. Participants included 2 between ages 65 and 70 years and 12 >80 years; 1 Native American, 13 European Americans; 1 divorced, 1 married, 5 widowed, and 7 never married. The mean MMSE score was 29 ± 1. Mean BMI was 29 ± 8 with 1 participant BMI <18, 4 participants BMI 18-25, 5 participants BMI 26-30, and 4 participants BMI >30. Among these 14 participants, 8 had a baseline systolic pressure above 140 mm Hg, 7 of whom were on at least 1 antihypertensive medication (Table 1).

Baseline mean systolic blood pressure was 147 ± 21, mean diastolic was 74 ± 14, and mean heart rate was 71 ± 12. The individual response to the sessions varies. In 9 of 12 sessions, heart rate decreased significantly, whereas systolic blood pressure and diastolic blood pressure achieved significance in only 2 of 12 sessions. Because of the small number of participants, the sessions were combined to determine whether a large sample would reveal a significant trend. The baseline mean systolic pressure for all sessions was 140 ± 19, mean diastolic pressure was 71 ± 13, mean heart rate was 71 ± 12. The postintervention mean systolic pressure for all sessions was 136 ± 19 mm Hg, mean diastolic pressure was 69 ± 11, and mean heart rate was 68 ± 11. Systolic ($P < .001$) and diastolic ($P < .005$) blood pressures and heart rate ($P < .001$) were reduced after the intervention (Table 2).

Reduction in blood pressure was statistically significant but of minor importance clinically. In considering the small sample size, percentage changes were used to examine individual differences in blood pressure and heart rate. On systolic pressures, 1 of 14 participants had an average of 2% increase, and 13 participants (93% of the sample) had an average of 3% decrease, with the mean reduction of 5.1 mm Hg after the intervention. On diastolic pressures, 2 participants had an average 5% increase, 1 participant had no percentage change, and 11 participants (79% of the studied sample) had an average 4.8% decrease with the mean reduction of 3.3 mm Hg after the intervention. For heart rate, 1 participant had an average 3% increase, and 13 participants (93% of the sample) had an average 4.8% decrease after the intervention (Table 3).

Table 1.
Medication List & Baseline Systolic Blood Pressure

Medication \ Subjects	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A2RB										√				
A2RB_Thiazide													√	
ACEI			√			√			√					
Beta Blocker			√			√	√							
CCB		√		√										√
Diuretics 1_loop		√		√			√	√			√			
Diuretics 2_thiazide		√				√								
Inotropes/Pressor				√					√					
Potassium Sparing_Thiazide												√		√
Nitrate							√							
SBP > 140mmHg	●	●	●	●		●			●		●			●

A2RB=Angiotensin 2 receptor blocker;
A2RB_Thiazide=Angiotensin 2 receptor blocker & thiazide combination;
ACEI=Angiotensin-converting enzyme inhibitors;
CCB=Calcium channel blocker;
SBP=Baseline systolic blood pressure.

The heart rate variability mean pre-post difference was found not statistically or clinically significant. Baseline mean heart rate was 71 ± 14, mean RMS-SD was 76 ± 120.7, mean SDNN was 64 ± 92, mean lnHF was 3.7 ± 2.8, mean lnLF was 4.1 ± 2.4, mean lnVLF was 4.6 ± 1.5, LF/HF ratio was 0.4 ± 0.9, mean Total Power was 5.5 ± 2.1. The exit mean heart rate was 67.7 ± 12.1, mean RMS_SD was 91.3 ± 174.2, mean SDNN was 54 ± 73, mean lnHF was 3.9 ± 1.9, mean lnLF was 4.0 ± 2.2, mean lnVLF was 4.7 ± 1.6, LF/HF ratio was 0.6 ± 0.9, mean total power was 5.5 ± 1.8 (Table 4).

Discussion

In addition to demographic data, BMI and cardiac medications were assessed to help characterize major factors in cardiac health within the sample group but were not part of the inclusion criteria. Participants' BMI was distributed across 4 categories: 7% BMI <18 (underweight), 28% BMI 18-25 (healthy), 35% BMI 26-30 (overweight), and 28% BMI >30 (obese) with a mean BMI of 29. The only participant who was normotensive had BMI <18. This finding seems to support the positive link between increased BMI, especially >30, to hypertension.[65] On the use of antihypertensive medication and blood pressure management, 7% of participants were normotensive and were not on antihypertensive medication, 7% had systolic pressure >140 mm Hg but were not on antihypertensive medication, 36% were normotenstive with the antihypertensive medication treatment, 50% had systolic pressure >140 mm Hg while under the antihypertensive medication treatment. This finding is similar to a nationwide study showing that among hypertensive elderly aged ≥80, the rate of controlled hypertension was suboptimal.[66]

Table 2.
Pre-Post Baseline Blood Pressure Comparison

	Pre		Post		
Variables	M	SD	M	SD	p
Systolic	140	19	136	19	<.001
Diastolic	71	13	69	11	<.005
Heart rate	71	12	68	11	<.001

Hypertension Management in Older Adults

Common hypertension management for older adults includes antihypertensive medication therapy and lifestyle modification. Lifestyle modification consists of sodium reduction, weight loss, balanced diet, sufficient physical activity, moderate alcohol consumption, smoking cessation, and stress management. The intervention

Table 3.
Percentage Change in Systolic, Diastolic Blood Pressure and Heart Rate

Parameters	Change	N Number (%) (Total N=14)	Mean % Change	Mean Change
Systolic	Increase	1 (7)	2	2.3 mm Hg
	No Change	0 (0)	0	0 mm Hg
	Decrease	13 (93)	3	5.1 mm Hg
Diastolic	Increase	2 (14)	5	2.3 mm Hg
	No Change	1 (7)	0	0 mm Hg
	Decrease	11 (79)	4.8	3.3 mm Hg
Heart Rate	Increase	1 (7)	3	1.75 bpm
	No Change	0 (0)	0	0 bpm
	Decrease	13 (93)	4.8	3.4 B bpm

in the study provides an additional strategy to modify a person's lifestyle with the focus on sympathetic reduction using a relaxation technique.

After 12 sessions of brief guided-relaxation training, decreases in the systolic and diastolic blood pressure for the group were noted, with more reduction on systolic pressures. The changes in blood pressure reached statistical significance at the group level but were not sufficient at the individual level to meet the recommended requirement of clinical significance.[67-70] Although the result is not clinically significant given that this is a pilot study with a small sample of 14 participants with mild to moderate hypertension, the study suggests that guided relaxation is a step toward cardiovascular improvement.

Physiologic changes are difficult to augment because a person's blood pressure is limited in how far it can decrease. It has been suggested that a 5-mm Hg reduction in systolic blood pressure would result in a 7% reduction in all-cause mortality, a 9% reduction in coronary heart disease–related mortality, and a 14% reduction in stroke-related mortality.[71-73] In this study, 13 of 14 participants (93%) lowered their systolic pressures with the mean reduction of 5.1 mm Hg. This finding supports a previous study by Patel and Datey[47] showing that biofeedback-assisted relaxation and meditation successfully reduced blood pressure. In his study, 70% of the participants achieved statistically significant reduction in blood pressure, and 50% of the participants were able to reduce their antihypertensive medication dosage. Although this study did not show a decrease in the use of antihypertensive medication, both studies showed similarities in their results.

Table 4.
Pre-Post Heart Rate Variability Comparison

	Pre (N=14)		Post (N=14)			
Variables	M	SD	M	SD	t	p
HR	71	14	67.7	12.1	1.21	.25
RMS-SD	76	120.7	91.3	174.2	−0.36	.72
SDNN	64	92	54	73	0.31	.76
lnHF	3.7	2.8	3.9	1.9	−0.30	.77
lnLF	4.1	2.4	4.0	2.2	0.12	.91
lnVLF	4.6	1.5	4.7	1.6	−0.15	.89
LF/HF	0.4	0.9	0.6	0.9	1.14	.28
Total Power	5.5	2.1	5.5	1.8	0	1

HR = heart rate; HF = high frequency; LF = low frequency; RMS-SD = square root of the mean squared differences of successive NN intervals; SNNN = standard deviation of NN intervals; ln = natural logarithm.

Previously reported studies have shown evidences of blood pressure reduction after a relaxation intervention, but the degree of changes between systolic and diastolic blood pressures varied across studies. Although the results were statistically significant, some studies showed more reduction in diastolic pressure,[49,50] whereas others,[46,48] as well as our study, showed more reduction in systolic pressure. The relatively more important change in systolic pressures is an encouraging finding with our sample in which there was a higher prevalence rate of isolated systolic hypertension. Although diastolic blood pressure remains normal or decreases with age, elderly people develop a widening of their pulse pressure (the difference between the systolic and the diastolic blood pressure) due to stiffness of the vascular wall. The findings on blood pressure change in this study provide promising support for the role of self-regulation in cardiovascular training in an older adult population with a mean age of 80 years and isolated systolic high blood pressure.

Heart Rate Variability Measurement in Older Adults

Total power and LF/HF ratio are the major indexes in HRV frequency measurement because they represent the overall balance of the autonomic nervous system. In this study, total power remained unchanged on pre- and post-measures, whereas the changes on LF/HF were not significant. Comparison of our HRV results with previous studies was limited because of a lack of literature on the impact of relaxation to HRV in older adult populations.

Increasing the variability in heart rate is a benefit to older adults in that it helps them to compensate for changes in physical activity. There are 3 main challenges in improving HRV. HRV naturally decreases with age, decreases with high blood pressure, and is often negatively affected by medications.[16,63] The participants in this study were older adults with generally mild to moderate hypertension. The average age of participants was 83. One of the participants was normotensive and on no medication, 1 had untreated hypertension, and the rest were on at least 1 antihypertensive medication. Antihypertensive medication such as beta-blockers, angiotensin-converting enzyme inhibitors, and calcium channel blockers have been shown to minimize HRV, specifically the sympathetic component.[74-77] These factors may explain the limited change in HRV in this study.

Findings from this study are in agreement with previous studies[44,45,47-49] with similar intervention concepts using mind modulation and baroreflex stimulation of the ANS for blood pressure reduction. These studies, including our pilot study, provide evidence to support the effectiveness of nonpharmacological approaches as an adjunct therapy for blood pressure reduction. The unique aspects of our study include the fact that the intervention is brief (12 min), so that it can be easily adopted as a self-help tool in the home or community setting. The intervention combines the use of guided imagery, cognitive rescripting, and abdominal breathing. Our sample was the oldest (83 years old) among retrieved studies, and the measurement of HRV was included, although the findings on HRV were not significant.

Our team was impressed by how engaged each participant was with the program. All participants, except the 3 who withdrew because of illness, completed the 12-session intervention within 3-6 weeks. Participants gave positive feedback about the audio relaxation program. Following are participant comments on the breathing technique they learned from the program:

- "*through this experiment, I learned a new way of breathing. I think I breathed too shallow in the past. Now I am practicing deep abdominal breathing*."
- "*I like this man's voice* [the program's speaker]. *He is my friend. Now I get to listen to him and maybe he will tell me whether he had a good weekend. I would like to come for another 12 sessions. I like my old friend. He talks to me and congrats me at the end*."

At the conclusion of the program, many participants requested that we continue the program or that a similar program be offered at the facility.

Limitations

Limitations of this study include the small sample size and the fact that it comprised a predominantly female, Caucasian, self-selected group of participants. Further limitations are the challenge of measuring short-term HRV in older adults who are on hypertensive medications known to alter the ANS and the fact that information on antihypertensive medication after intervention was not collected. Also, variables were measured for a relatively short period of time, so it is unknown whether the positive cardiovascular changes were sustained.

Implications

The finding of this study provides support that a brief session of audio-guided relaxation has the potential to reduce blood pressure in hypertensive older adults. It is unclear at this time whether this intervention can be used independently, but it shows promise as a potential adjunct to medication. Older adults often comment on the difficulties of taking numerous medications, as well as on the problems posed by the cost and side effects of these medications. Studies estimate that 55%-67% of patients do not take prescribed medications.[78] A combined approach integrating the medical effort and inborn self-regulation skills should be considered for more client-centered care. Guided relaxation is under the nursing scope of practice, and nurses may use it to assist older adults in gaining a sense of control in their hypertensive treatment plans.

Recommendations

On the basis of this study and the literature, there is evidence to encourage clinical nurses to use guided relaxation with hypertensive older adult patients. This can be achieved by informing elderly clients about the availability of a relaxation program, encouraging its regular use, and assisting patients in using a CD player or other technology. Research has not established the ideal program length. It is unclear whether such an intervention should continue indefinitely. This intervention is best done in a quiet, familiar environment and with a personal CD player. To determine effectiveness, clinical nurses can monitor clients' blood pressure, perhaps in weekly rounds, to assess for changing trends in blood pressure. This is an important aspect in using self-regulation: clients who are aware of changes are more likely to continue a program to sustain those changes. As blood pressure drops, medication should be reassessed.

Conclusion

This study provides evidence to support the effectiveness of psychologically based relaxation techniques for sympathetic reduction of blood pressure in an older adult population, even at age ≥80. Future study in this area should follow participants for a longer period to identify changes related to guided relaxation. A larger sample size, coupled with a randomization sampling strategy, and use of a control group would help to clarify the influences of guided relaxation on cardiovascular health.

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