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Influence of Seated Rocking on Blood Pressure in the Elderly: A Pilot Clinical Study

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Patients with Alzheimer's disease (AD) who rock for 1–2 hr per day in a rocking chair demonstrate significant improvements in depression, anxiety, and balance and a decrease in pain medication usage; however, the underlying basis for their responses remains unclear. Rocking with plantar flexion uses the calf muscles, enhancing lower limb fluid return to the heart, which should increase blood pressure (BP) and may, then, also increase cerebral perfusion. Accordingly, we tested the efficacy of rocking activity for increasing BP in healthy, older persons. In a pilot laboratory study of 24 healthy, White men and women aged 55–87 years, we observed that 30 min of steady rocking led to an average 12 mmHg increase in systolic blood pressure (SBP, $p < .001$) and a 3.6 mmHg average increase in diastolic blood pressure (DBP, $p < .001$). To determine the effect of using this intervention in a nonclinical setting, we tested a similar group of 7 participants at a senior center. In this setting, we observed an average increase in SBP of 27 mmHg ($p < .001$) and in DBP of 2.5 mmHg ($p < .001$) after 30 min of rocking. In a subgroup ($n = 8$) of hypotensive individuals (SBP < 110 mmHg after sitting quietly for 30 min) extracted from both settings, rocking raised the average SBP from <100 mmHg to approximately 120 mmHg. These results are consistent with the hypothesis that rocking can increase BP and, therefore, may enhance cerebral perfusion. This observation may play a fundamental role in designing nursing interventions focused on improvement of symptoms associated with AD.

Keywords: Alzheimer's disease; hypotension; rocking chair

Exercise has been advanced as a possible intervention to prevent cognitive decline in the elderly. Numerous large, prospective studies have found that exercise may serve as both a preventative and therapeutic modality. For example, the Canadian Health Study followed over 4,000 persons 65 years of age and older who were cognitively normal at baseline for 5 years and found that physical activity was associated with lower risks of cognitive impairment (Laurin, Verreault, Lindsay, MacPherson, & Rockwood, 2001). Similarly, in a 6-year longitudinal study following 1,740 persons older than 65 years of age, Larson et al. (2006) found that those who exercised three times or more a week had a significantly reduced incidence of dementia. Once a diagnosis of Alzheimer's disease (AD) is suspected, 1 hr per week of an exercise program can lead to a significantly slower decline in activities of daily living scores in persons living in a nursing home compared to those persons who receive routine medical care (Rolland et al., 2007). Improvements in cognitive function have been most specifically noted in the area of executive function (Colcombe & Kramer, 2003; Hall, Smith, & Keele, 2001; Yu, Kolanowski, Strumpf, & Eslinger, 2006). Lange-Asschenfeldt and Kojda (2008) attributed the protective function of exercise to a mechanism by which the pathophysiology of AD is counteracted by the buildup of vascular reserve and plasticity.

Although these studies lend support to the positive influence of exercise on preventing or slowing the cognitive decline associated with aging, some studies

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have shown more equivocal relationships. In a study of over 700 persons 65 years and older who were followed for 4 years, exercise was associated with a lower risk of vascular dementia but not of AD (Ravaglia et al., 2008). Furthermore, exercise was not shown to be beneficial in altering the course of AD in persons with cardiovascular risk factors (Eggermont, Swaab, Luiten, & Scherder, 2006). These findings suggest that the common confounder of poor compliance in exercise studies on the elderly (Steele et al., 2008) may be playing an important role in studying the effect of exercise on dementia and that a simplified exercise regimen may help to ensure high compliance and, therefore, a consistent benefit.

One unique and particularly simple exercise intervention involves rocking in a rocking chair (Watson, Wells, & Cox, 1998). In a study of 25 institutionalized dementia participants, of which 23 had been diagnosed with AD, participants were asked to rock in rocking chairs daily for a period of 6 weeks. A crossover design with a 2-week washout between two treatment periods was used. Participants rocked for an average of 100 min per day, and it was observed that longer periods of time spent rocking were associated with significant improvements in depression, anxiety, and balance as well as decreased use of pain medications.

The mechanism by which rocking leads to these changes in AD patients is uncertain; however, these improvements might be attributed to improved perfusion of the brain. Dementia is well known to be associated with hypotension and hypoperfusion (Giu, Winblad, & Fratigliani, 2005; Skoog et al., 1996; Verhese, Lipton, Hall, Kuslansky, & Katz, 2003). Faulty autonomic function in maintaining cerebral perfusion has been suggested as a possible mechanism in all forms of dementia (Allan et al., 2006). Poor cerebral blood flow has been linked with poor cognitive performance (Duschek & Schandry, 2007; Osawa et al., 2004). Furthermore, Duschek, Hadjamu, and Schandry (2007) have shown that the use of a symphathetomimetic drug can be effective in improving cued reaction times and cerebral blood flow in persons with chronic hypotension. It has also been shown that blood pressure (BP) falls in persons with hypertension about 2 years before the onset of signs of dementia (Skoog et al., 1996; Skoog & Gustafsen, 2006). Although it is commonly believed that hypotension and decreased perfusion are secondary to the onset of dementia, these latter results have led numerous investigators to propose that hypoperfusion may be implicated in the initial development of dementia.

Although exercise is often set forth in health promotion and disease prevention programs, barriers to exercise in older adults are complex and may involve such issues as self-efficacy, attitude, discomfort, disability, poor balance, fear of injury, habit, subjective norms, fixed income, cognitive decline, illness, fatigue, and environmental factors (Nied & Franklin, 2002). Rocking provides a safe, low-impact activity that is largely free from risk of injury, is pleasant to most individuals, and can be done while doing other activities such as watching television or interacting with friends and family. Active rocking using a heel-to-toe motion (plantar flexion) involves contraction of the calf muscles, enhancing venous and lymphatic fluid return from the lower extremities to the heart (Rowell, 1993). Correspondingly, this enhanced fluid return should lead to an increase in BP. An increase in BP would lead to increased mean arterial pressure and, presumably, increased cerebral perfusion. We thus chose to measure the effect of rocking on systolic blood pressure (SBP) and diastolic blood pressure (DBP) in a healthy population of older men and women.

Approval was obtained from the institutional review board at Binghamton University prior to the outset of this research. This research took place in both the Clinical Science and Engineering Research Centers at Binghamton University and at a local senior center.

Methods

The purpose of this research was to test the effect of rocking in a rocking chair on BP in older healthy individuals. The primary hypothesis was that BP in older adult men and women would be significantly increased following 30 min of rocking in a rocking chair using a heel-to-toe motion (plantar flexion). A secondary hypothesis was that rocking would offset the adverse effects for those individuals who could not maintain their BP during quiet sitting. We also hypothesized that there would be no difference in the BP response to rocking between our laboratory setting and a nonresidential senior center.

Participants

Inclusion criteria included persons 55 years of age or older who were physically able to rock for 30 min. Individuals were excluded if they weighed more than

300 lb, had a lower extremity amputation, or a history of angina, renal failure, venous insufficiency, deep vein thrombosis, or pulmonary embolism. Recruitment of laboratory participants was done by advertising in a daily internal university listserv. Recruitment of nonresidential senior center participants was arranged through the administrator at the center.

Laboratory Protocol

On providing written informed consent, participants were seated in a rocking chair in a quiet, temperature- and humidity-controlled room with soft background music. They were connected to a Portapres Model 2 (Amsterdam, the Netherlands), which provided continuous beat-to-beat, automated finger arterial BP and heart rate (HR) monitoring. The Portapres was calibrated every 4 months to a mercury manometer. Although finger arterial BP recordings are typically 5–10 mmHg lower than brachial BP measurements, such measurements conform well to invasive measurement (Imholz, Weiling, van Montfrans, & Wesseling, 1998) and are highly reproducible (Voogel & van Montfrans, 1997). Participants were then asked to sit quietly without talking for a period of 30 min. Following the quiet sitting period, participants were asked to rock back and forth at a regular, comfortable pace using a heel-to-toe motion that contracted the calf muscles to activate the calf muscle pump for an additional 30-min period during which BP and HR were continually recorded.

Senior Center Protocol

Testing undertaken at the senior center used the same equipment and essentially the same protocol. The room used, however, was a small private room without music.

Data Analysis

Laboratory and senior center data were analyzed separately. Beat-to-beat BP and HR data were normalized such that time 0 represented the moment when each participant started rocking. Each participant's data was averaged, and these time series data then were averaged for three 1-min time periods including 0–1 min of quiet sitting, 29–30 min of quiet sitting, and 29–30 min of rocking. The hypotensive subgroup participants were selected from the entire participant population based on the criterion of having an average SBP of less than 110 mmHg after 30 min of quiet sitting, as measured during the last min of quiet sitting (Eastridge et al., 2007). Descriptive statistics were computed and *t* tests performed using Origin 7.0. Statistical significance was established at $p = .05$. All data are reported as mean $\pm$ standard deviation.

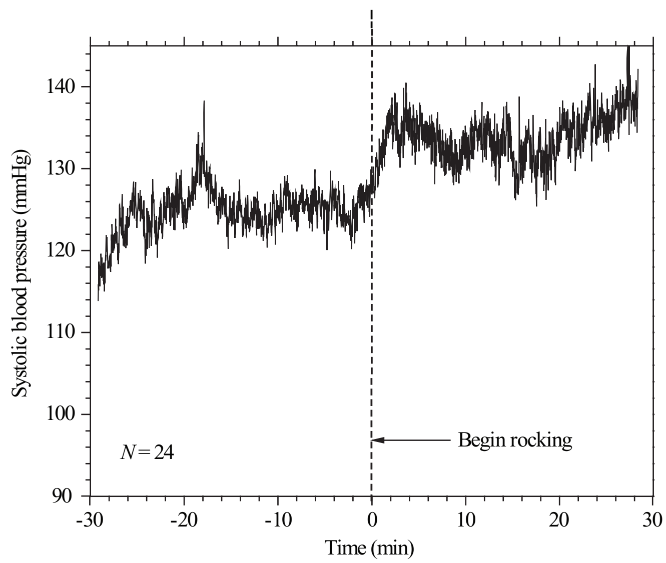

Figure 1. Mean systolic blood pressure (SBP) while participants were sitting and rocking in the laboratory setting. Rocking activity was initiated at time = 0 and resulted in an approximately 12 mmHg rise in SBP ($p < .001$).

Results

Participants included 24 older adults with an age range of 55–87 years (70.6 $\pm$ 9.5 years) who met the inclusion criteria and described themselves as generally healthy participated in the laboratory study. All were White, and 58% were female. Of these participants, 64% took some form of antihypertensive medication routinely, and at the time of this study, the BP of all participants was well controlled.

The mean SBP for these participants on sitting down (averaged over the first 1 min) was 118 $\pm$ 1.7 mmHg (see Figure 1). Following 30 min of quiet sitting, their mean SBP had risen to 126.9 $\pm$ 1.4 mmHg. Similarly, mean DBP was 61.3 $\pm$ 1.0 mmHg on sitting and rose to 65.4 $\pm$ 0.8 mmHg following 30 min of quiet sitting (see Figure 2). The initiation of rocking resulted in a rapid rise in SBP of approximately 10 mmHg within

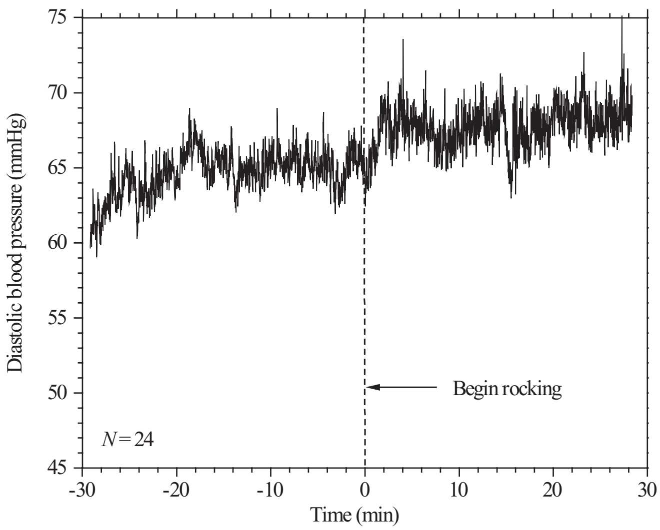

Figure 2. Mean diastolic blood pressure (DBP) while participants were sitting and rocking in the laboratory setting. Rocking activity was initiated at time = 0 and resulted in an approximately 4 mmHg rise in DBP ($p < .001$).

3 min, with a slower progressive increase occurring over the 30 min, resulting in a final mean SBP of 138.8 ± 2.2 mmHg for a net increase of approximately 12 mmHg ($p < .001$). Similarly, DBP rose to 69 ± 1.2 mmHg ($p < .001$), principally within the first 3 min of the initiation of rocking. Although a slight drop in HR was observed during the rocking, this decrease was not significant.

An additional 7 participants (mean age of 77.1 ± 7.1 years), comprising four women and three men, were evaluated in a local senior center (Table 1). Of these, 86% routinely took antihypertensive medication. The mean SBP of these participants after 1 min of sitting was 115.3 ± 3.5 mmHg, which rose to a mean of 124.3 ± 4.5 mmHg after quiet sitting. After 30 min of rocking, the mean SBP of this group rose to 151.1 ± 0.6 mmHg ($p < .001$). DBP during the 1st min of sitting was 56.8 ± 1.9 mmHg, which rose to 60.4 ± 1.9 mmHg after 30 min of quiet sitting. Rocking increased the mean DBP to 62.7 ± 2.6 mmHg after 30 min ($p < .001$).

Over one quarter (8/31) of our participants were hypotensive (SPB < 110 mmHg) following 30 min of quiet sitting. In this subgroup, average SBP on sitting was 103 mmHG (see Figure 3). After 30 min of quiet sitting, participants' mean SBP dropped by 5 mmHg, bringing the mean SBP to below 95 mmHg. At the onset of rocking, mean SBP rose to over 110 mmHg within the first 6 min, then continued to rise to approximately 120 mmHg by the end of the 30 min of rocking activity ($p < .001$). Mean DBP in this subgroup started at approximately 54 mmHg and dropped below 50 mmHg during quiet sitting. Rocking resulted in a rapid 4 mmHg increase followed by a continued rise, which resulted in a final DBP of approximately 55 mmHg following 30 min of rocking ($p < .001$; see Figure 4).

Discussion

Results of this research indicate that BP can be significantly increased in healthy older persons by active rocking in a rocking chair. We observed that rocking, on average, produced a 10–15 mmHg rise in SBP, which increased from approximately 125 to 140 mmHg in our study population. This finding varies from that of a previous study of elders who showed no change on BP after rocking (Houston, 1993). However, in that study, the rocking period was only 10 min in duration and BP measurements were only taken at 5-min intervals. In a study using a glider swing to evoke a relaxation response in elders with dementia, researchers noted a decrease in heart and respiratory rates as well as an increase in emotional pleasure and relaxation (Snyder et al., 2001), but they reported no BP data.

Because of the suggested role of hypotension in the etiology of AD, we focused on the subgroup of our participants who were hypotensive (SBP < 110 mmHg after 30 min of sitting). This group was predominantly female (seven women and one man) and had an average age of 74 years. Of particular interest was the fact that 5 of these participants were taking prescription antihypertensive medications. Of the 8 hypotensive participants, 2 were recruited from the senior center, whereas 6 were recruited for the laboratory study. The similarity in ratios of hypotensive individuals to all participants in each group leads us to suggest that about 25% of individuals in this age group are likely to be hypotensive. In addition to being hypotensive, this subgroup also demonstrated a declining BP on taking a seated position. This is in contrast to the other members of the study population, who experienced an increase in BP while sitting, which is the expected response to the decreased orthostatic stress of sitting, as reported in a study of young, healthy males (Shvartz, Reibold, White, & Gaume, 1982). That 25% of our study population would demonstrate such a decline in BP while seated is consistent with a recent report on the

Table 1. SBP, DBP, and HR Data for Elders in Laboratory (CSERC) and SC Settings at 1 and 30 min of Quiet Sitting and After 30 min of Rocking in a Rocking Chair

	CSERC			SC		
	1-Min Quiet Sitting	30-Min Quiet Sitting	30-Min Rocking	1-Min Quiet Sitting	30-Min Quiet Sitting	30-Min Rocking
SBP (mmHg)	117.99 ± 1.7	126.89 ± 1.4	138.81 ± 2.2	115.28 ± 3.5	124.25 ± 4.5	151.10 ± .62
DBP (mmHg)	61.30 ± .98	65.42 ± .76	69.01 ± 1.2	56.8 ± 1.9	60.39 ± 1.9	62.74 ± 2.6
HR (bpm)	66.3 ± 6.5	66.2 ± 6.5	63.9 ± 7.2	66.2 ± 9.4	68.8 ± 10.2	69.1 ± 9.8

NOTES: Values are mean ± standard deviation. Bpm = beats per min; SBP = systolic blood pressure; DBP = diastolic blood pressure; HR = heart rate; SC = senior center; CSERC = Clinical Science and Engineering Research Center.

prevalence of delayed orthostatic hypotension in a healthy adult female population (Madhavan, Goddard, & McLeod, 2008). Despite a drop in average SBP to as low as 95 mmHg in the hypotensive subgroup, rocking activity resulted in a substantial (20 mmHg) increase in SBP. This increase was sufficient to move the group's average SBP into the normotensive range.

Changes in HR for both groups were minimal in spite of the changes in BP. This observation is consistent with the blunted autonomic response reported in elders (Bowman et al., 1997; Mattace-Raso et al., 2006; Sevre et al., 2001).

The increase in SBP noted in these findings may be sufficient to explain the improved behavior observed in AD patients during rocking. The relationship between BP and cognitive function has been extensively studied. A U-shaped association between cognitive impairment and SBP has been consistently reported, with SBP between 130 and 160 mmHg being associated with the lowest risk of cognitive impairment (Glynn et al., 1999). Similarly, it has been demonstrated that an SBP lower than 130 mmHg is predictive of cognitive impairment in older participants with heart failure (Zuccala et al., 2001). Elderly participants with lower daytime BPs were found to have more impaired cognitive function as well as decreased levels of independent activities of daily living (Ohya et al., 2001). Improved cerebral blood flow, as noted in the middle cerebral arteries using Doppler sonography, was associated with improved serial subtraction performance in persons with constitutional hypotension (Duschek & Schandry, 2006).

A drop in BP commonly occurs before symptoms of dementia are demonstrated (Skoog et al., 1996; Skoog & Gustafsen, 2006). Although persons who developed dementia in one study had higher SBP and DBP at age 70 than those who did not develop dementia, the BP of those who developed dementia declined in the years before the onset of dementia to a similar or lower level than that of the nondemented individuals (Zuccala et al., 2001). Similarly, researchers described a strong inverse relationship between both SBP and DBP, and dementia in those participants with an SBP $\leq$ 140 mmHg and a DBP $\leq$ 75 mmHg, demonstrating a significantly elevated risk for dementia (Guo, Vitanen, Fratiglioni, & Winblad, 1996).

A continued decline in BP during the course of AD has been reported over a 1-year time period, and those persons with the worst cognitive impairment at baseline showed the largest decrease in BP (Hanon et al., 2005). These declines have been shown to be independent of age, gender, body mass index, and antihypertensive therapy. Similarly, vascular dementia, the second most common type of dementia, has been attributed to hypoperfusion and cerebral microembolism (Roman, 2002). The resultant "cardiogenic dementia" might have various origins, including impaired cerebral blood flow related to the hypotension as well as the possibility of impaired autoregulation of cerebral circulation seen in elders. Autonomic dysfunction was found to be present in all common dementias via assessment of several clinical autonomic function tests using Ewing's criteria (Allan et al., 2006). A causal link has been suggested between cerebral ischemia and AD based on autopsy evidence of AD pathology in cases with cerebrovascular disease or vascular dementia even though no symptoms of AD were evident prior to death (Kalaria, 2000).

The present study had a number of limitations. All participants were White, and the population was relatively young in comparison to the typical AD population. Although symptoms associated with AD are usually initially observed in the sixth and seventh decades, cognitive decline is principally noted in the eighth and ninth decades. Prevalence of AD is 50% at age 85. Many of the participants were taking antihypertensive medications routinely, and these

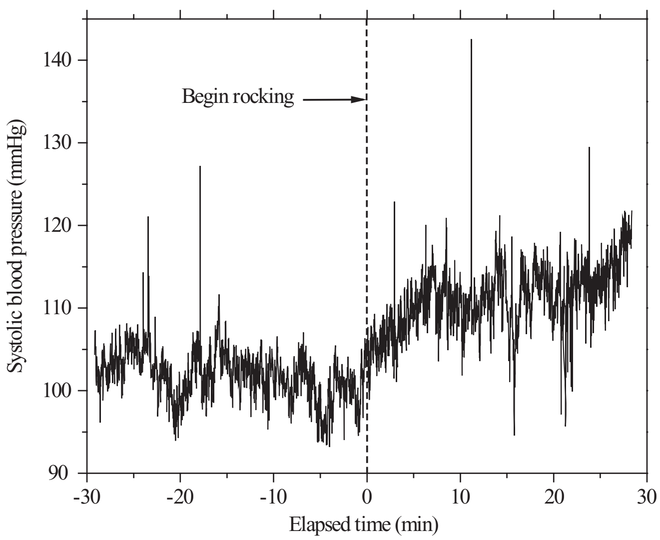

Figure 3. Mean systolic blood pressure (SBP) in the hypotensive subgroup ($n = 8$) while participants were sitting and rocking in either the laboratory or the residential center setting. Rocking activity was initiated at time = 0 and produced an approximately 20 mmHg increase in SBP, resulting in the average SBP of this subgroup reaching normotensive range.

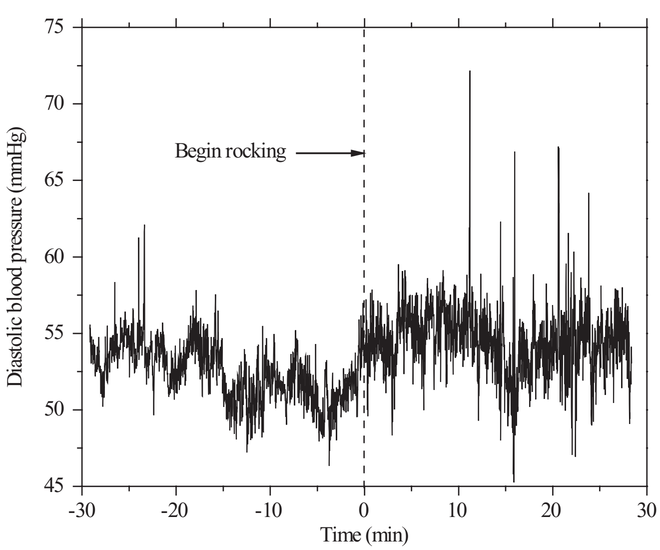

Figure 4. Mean Diastolic blood pressure (DBP) in the hypotensive subgroup ($n = 8$) while sitting and rocking in either the laboratory or the residential center setting. Rocking activity was initiated at time = 0. The 8 participants demonstrated an average DBP of about 54 mmHg, which dropped below 50 mmHg while sitting but returned to 55 mmHg while rocking.

medications may have blunted the BP, depending on the plasma concentration at the time of testing. Scheduling participants throughout the day and afternoon hours may have moderated this effect somewhat, but future research should take this possibility into consideration. It was particularly interesting that 7 of the 8 hypotensive participants in our study were on hypertension medications, suggesting a need for reevaluation of all medications but most especially those with vasoactive actions. Finally, participants were asked to rock back and forth using a heel-to-toe motion, but individual speeds and intensities emerged. The participants were gently reminded how to rock, but this variation is a limitation to this study. Future research based on these pilot data should expand the sample size and focus on changes in cognitive function in persons who are diagnosed with or developing some of the initial symptoms of AD.

The results of this study may help to explain how activity is able to improve the behavior of AD patients. In addition, these results suggest an alternative intervention to slow the progression of AD or improve the function of AD patients through improved cerebral perfusion in persons with chronic and/or delayed hypotension (Madhavan et al., 2008).

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