THE EFFECTS OF SWIMMING TRAINING ON ARTERIAL STIFFNESS, MUSCULAR STRENGTH, AND CARDIORESPIRATORY ENDURANCE IN POSTMENOPAUSAL WOMEN WITH STAGE 2 HYPERTENSION

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BACKGROUND

- Advanced aging has been known to decrease cardiovascular health, muscular strength and cardiorespiratory endurance, with more severe declines observed in postmenopausal women
- Due to perceived or actual barriers associated with traditional land-based exercise (musculoskeletal injury and exertion related to heat load), many older women have difficulty adhering to typical exercise training programs
- Water immersion decreases heat load as well as axial loading of the spine, and therefore swimming may serve as an excellent form of exercise for hypertensive elderly individuals who may be unable to perform conventional land-based exercises
- The effects of swimming on cardiovascular health and cardiorespiratory endurance have been mixed, however, and the effects of swimming on muscular strength are largely unknown

PURPOSE

- To determine the effects of a 20-week swimming training program on arterial stiffness, muscular strength and cardiorespiratory endurance in postmenopausal women with stage-2 hypertension

METHODS

- 100 women (67-85 years old) who were post-menopausal (cessation of menstruation for 1 year) with stage-2 hypertension (SBP of 140+ or DBP of 90+) were randomly assigned to 20-weeks of swimming or a sedentary control group
- For the first 5 weeks, subjects swam at 60% of HRmax for 30 min, 3 days/week. They then progressed to 70% of HRmax for 45 min, 3 days/week.
- Each subject was instructed to swim continuously except during the time needed for checking target heart rate
- The control subjects came to the lab at the same frequency as the experimental subjects, but did not participate in exercise
- All measurements were obtained at baseline and at 20 weeks at the same time in the morning (±1 hour) after an overnight fast and 10 minutes of rest in the supine position
- Cardiovascular function was measured by blood pressure cuff and applanation tonometry (crPWV and AIx)
- Muscular strength was determined by maximal isometric grip strength of the dominant arm (in duplicate) using a handgrip dynamometer
- Cardiorespiratory endurance was measured using the Cornell modification of the Bruce treadmill protocol and a metabolic cart. VO2max was defined as the highest 30 second value of O2 uptake
- Data was analyzed using a two-way analysis with repeated measures (group x time) within and between groups. A Tukey test was used post hoc. ∝ = 0.05

RESULTS

Table 1. Subject characteristics before and after 20 weeks of SWM or control

	CONTROL		SWM	
Variable	Before	After	Before	After
Age (years)	73 ± 4	74 ± 4	74 ± 4	75 ± 3
Height (m)	1.55 ± 0.05	1.55 ± 0.05	1.53 ± 0.06	1.53 ± 0.06
Body weight (kg)	62.3 ± 7.5	61.3 ± 5.3	61.3 ± 6.9	60.3 ± 7.8
BMI (kg/m^2)	26.9 ± 2.9	26.5 ± 2.9	26.0 ± 2.8	25.8 ± 3.5
Fat free mass (kg)	41.2 ± 6.7	39.3 ± 7.2	39.4 ± 4.3	41.8 ± 5.2*†
Fat mass (kg)	19.5 ± 2.2	21.6 ± 3.2	22.4 ± 2.2	19.2 ± 2.1*†
Body fat (%)	31.2 ± 2.3	32.5 ± 3.3	36 ± 3.6	33 ± 4.1*†

Values are Mean ± SD, * P < 0.05 different than before, † P < 0.05 different than control

Table 2. Arterial function, muscular strength and cardiovascular endurance before and after 20 weeks of SWM or control

	CONTROL		SWM	
Variable	Before	After	Before	After
Systolic BP (mmHg)	144 ± 1	145 ± 1	146 ± 1	135 ± 1*†
Diastolic BP (mmHg)	91 ± 1	91 ± 1	88 ± 1	79 ± 1*†
AIx @ 75 (%)	30 ± 2	31 ± 2	31 ± 3	25 ± 2*†
crPWV (m/s)	9.4 ± 0.2	10.0 ± 0.2	9.0 ± 0.2	7.8 ± 0.3*†
Heart Rate (bpm)	71 ± 2	72 ± 2	68 ± 2	61 ± 2*†
Handgrip Strength (kg)	25 ± 1	24 ± 1	24 ± 1	27 ± 1*†
VO$_2$max (mL/kg/min)	24 ± 3	23 ± 4	22 ± 2	26 ± 3*†

Values are Mean ± SD, * P < 0.05 different than before, † P < 0.05 different than control

RESULTS

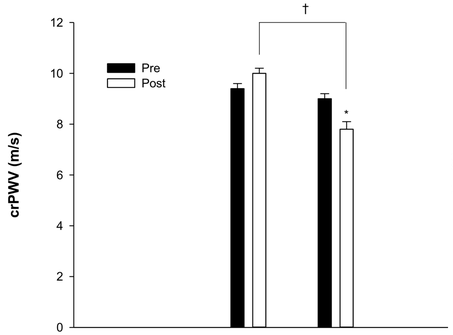

Figure 1. Carotid-to-radial pulse wave velocity (m/s) before and after swimming training between the swim (SWM) and the control groups.

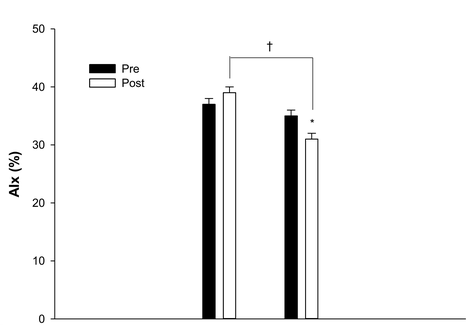

Figure 2. Augmentation index (%) before and after swimming training between the swim (SWM) and the control groups.

Values are Mean ± SE, * P < 0.05 different than before, † P < 0.05 different than control

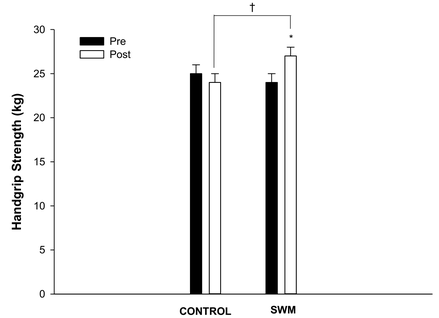

Figure 3. Handgrip strength (kg) before and after swimming training between the swim (SWM) and the control groups.

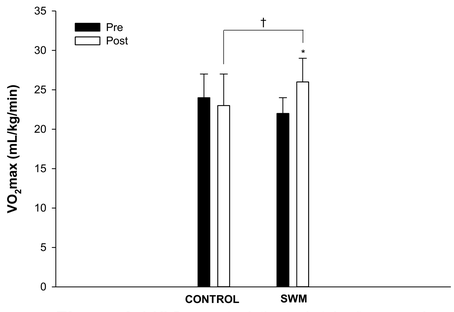

Figure 4. VO2max (mL/kg/min) before and after swimming training between the swim (SWM) and the control groups.

CONCLUSION

- We found that 20 weeks of SWM training resulted in reductions in arterial stiffness and blood pressure and improvements in isometric muscle strength and VO2max
- These improvements have significant clinical implications based on previous findings
- Increases in baroreflex sensitivity and endothelial function could be related to the improvements in arterial stiffness and blood pressure
- Our results indicate that swimming can be a beneficial exercise modality to improve cardiovascular health and physical fitness in postmenopausal women with stage 2 hypertension