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Hypertension, Aerobic Exercise, and Timing

Brito LC, Pecanha T, Fecchio RY, Rezende RA, Sousa P, DaSilva-Junior N, Abreu A, Silva G, Mion-Junior D, Halliwill JR, Forjaz CL. Morning versus evening aerobic training effects on blood pressure in treated hypertension. Med Sci Sports Exerc. 2019;51(4):653–62.

Hypertension is the most common cardiovascular risk factor, associated with 8 million deaths per year (1). There are currently 75 million Americans (2) and 6 million Australian (3) adults (1 out of 3 people in both countries) who have been diagnosed with hypertension. Although antihypertensive medications are an effective method to control hypertension, physical activity has also been shown to be an important complimentary treatment to reduce and control blood pressure (BP) (4). It is well documented that aerobically based exercise performed 2 to 3 times per week for an average of 30 min (moderate intensity) per session results in an average reduction of systolic (−8 mm Hg) and diastolic (−5 mm Hg) BP for most people (5).

Although aerobic exercise is an accepted recommendation to help manage hypertension, there are still unknown factors (e.g., genetics, diet, exercise variables, etc.) regarding the most effective dose of aerobic exercise to maximize BP reductions (6–8). Several studies demonstrate that acute aerobic exercise performed during the evening (6pm to 9pm) resulted in greater BP and systemic vascular resistance (SVR) reductions compared to exercise that occurred in the morning (8). When lowered, SVR is a primary mechanism associated with the explanation of BP reductions as a result of exercise training (8).

Exercise session timing is an inexpensive and simple adjustment that can be made to exercise programming. It is currently unknown if aerobic training conducted on a chronic basis and during the evening will result in reductions in BP as seen with acute or single bouts of aerobic exercise.

MANUSCRIPT REVIEW

The purpose of this investigation was to compare BP change associated with chronic evening versus morning aerobic training and assess if evening training could be used as a method to enhance BP reductions. Based on previous research with acute exercise, the authors of this study hypothesized that 10 weeks of evening aerobic training would have superior chronic reductions in BP when compared to morning training. Men (age 30-65 years) living in the São Paulo area of Brazil were recruited to participate. Inclusion criteria included age, resting systolic and diastolic BP < 160 mm Hg and < 105 mm Hg, respectively, and treated with an antihypertension medication without change in dosage for the previous 4 months. Patients underwent a physical exam to determine resting BP (average of 6 measures on 2 separate days), measure height, weight, body mass index, perform a resting electrocardiograph (ECG), collect blood and urine samples to rule out organ damage and secondary hypertension, and determined chronotype, related to circadian rhythm based on sleep patterns, by completing the Horne and Ostberg questionnaire (9).

The study was a randomized, controlled trial that used the primary outcome of resting BP and the secondary outcome of autonomic function. Patients were randomized to 1 of 3 groups (evening training [ET] 6-8pm; morning training [MT] 7-9am; controls [CT]). The times selected were to control for circadian effects of BP increases and decreases during the evenings and mornings. Patients engaged in 10 weeks of training that included three 30 to 45-min sessions of progressive lower body cycling. During cycling the intensity was set to the heart rate associated with each participant's anaerobic threshold determined during the initial graded exercise testing (GXT) and progressively increased every 2 weeks until the heart rate of 10% below respiratory compensation threshold was achieved. Duration gradually increased from 30 to 45 min over the first 4 weeks of training. Control patients performed three 30-min sessions of static stretching.

Pre-post testing was completed within 3 to 4 d prior to and after the 10-week intervention, and included 2 GXTs during the evening and morning time periods with 2 d between each test. During GXT, BP was taken every 2 min and heart rate, ECG, and expired gas were continually measured. For resting BP all patients reported to the laboratory with at least 4 h of fasting. Patients were fed a standardized meal 30 min prior to the first resting BP measure. All resting BP measures were conducted with patients during both the morning and evening sessions with at least 2 d between each measure. Cardiac output was calculated via the indirect Fick method of CO_2 rebreathing, and SVR was calculated as mean BP/cardiac output. Autonomic modulation of the cardiovascular system was measured using heart rate (measured with R-R interval on ECG) and beat-by-beat BP (measured with photoplethysmography and thoracic piezoelectric belt) variability.

A total of 210 individuals were screened for this study; 88 men agreed to participate (32 patients dropped after the initial evaluation), and 56 patients were randomized to the 3 groups (ET [n=18], MT [n=18], and CT [n=20]). During the 10-week intervention 3 individuals dropped from both ET and MT groups, resulting in 50 patients completing the study. Results demonstrated that the 3 groups were not different in age, anthropometrics, resting BP, or chronotype. Both groups improved VO_2 and did not reduce body weight following the exercise intervention.

Results for resting BP and SVR in the morning session were lower measures in both the ET and MT group when compared to the control group. Resting morning systolic BP and SVR had the greatest reductions in the ET group. Following evening measures, only the ET group's systolic BP was significantly reduced when compared to the MT and CT groups. There were no significant differences in evening resting BP between the MT and CT group. Resting diastolic BP reductions were observed in the ET group in both the morning and evening measures; however, neither measure was significantly different when compared to the MT and CT group. There were no changes in cardiac output for any of the groups.

CLINICAL IMPLICATIONS

This is the first study to investigate the effects of chronic aerobic training in the evening versus morning for BP reduction in men prescribed antihypertension medication. The major findings of this study were that aerobic exercise in the evening resulted in significant reductions in systolic BP and SVR when compared to morning training. Both evening and morning training resulted in improved cardiorespiratory fitness, reductions in resting BP, and reductions in resting heart rate when compared to the control group. The findings of this study exemplify the importance of physical activity and exercise as a complimentary method to manage BP. If it is feasible, clinical exercise physiologists should encourage evening exercise training in this type of persons. Additionally, the clinical exercise physiologist should remind all patients that exercise at any time of day is better than a sedentary lifestyle based on the overall health-related benefits. Further research needs to be conducted with females, different intensity levels, and types of exercise (i.e., resistance training).

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Spinal Cord Injury, Thermoregulation, and Upper-Limb Exercise

Au JS, Kamijo Y, Goosey-Tolfrey VL, Leicht CA, MacDonald MJ, Mukai Y, Tajima F. Comparison between esophageal and intestinal temperature responses to upper-limb exercise in individuals with spinal cord injury. Spinal Cord. 2019;2:1–8.

There are more than 250,000 people in the United States (1) and 15,000 people in Australia (2) living with a spinal cord injury (SCI). Depending on the level of the damage to the spinal column, SCI is classified as paraplegia (paralysis of legs/lower body) or tetraplegia (paralysis of four limbs) (1). Regardless of classification, many individuals with SCI will have disrupted autonomic function (i.e., sympathetic nervous system dysfunction) resulting in the inability to efficiently thermoregulate increases in body temperature during activities of daily living or sport (3), posing a serious and potentially life-threatening risk. This illustrates the importance of the clinical exercise physiologist monitoring body temperature in patients with SCI (3). Due to disruptions of autonomic function in SCI, concerns with feasibility, validity, and sensitivity of different temperature measurement methods may exist (4).

Common locations for measuring core temperature during exercise include rectal or esophageal. These types of measurement are confined to the laboratory and may be challenging to administer in persons with SCI. An ingestible telemetric pill may be an alternative to provide an accurate indication of core temperature in persons with and without SCI and allow measures to be taken without requiring a laboratory setting (5,6). The limited research that does exist using telemetric measure of core temperature in persons with SCI is confined to wheelchair athletes and does not take into consideration the differences in gut motility between different types of SCI (7). If telemetric measures of core temperature are reliable, they may prove to be a noninvasive way to monitor heat stress in the nonathlete with SCI and could lead to improved safety of exercise programming.

MANUSCRIPT REVIEW

The purpose of this study was to investigate if intestinal temperatures (T_{INT}) via telemetric pills, and esophageal temperatures (T_{ESO}) provide comparable temperature information during upper body aerobic exercise in untrained men with paraplegia and tetraplegia. The authors of the study hypothesized that both T_{INT} and T_{ESO} would provide similar core temperature measures in persons with SCI. Males living in Wakayama, Japan were recruited to participate in this cross-sectional study. Seventeen individuals (12 with SCI [5 paraplegic and 7 tetraplegic] and 5 non-SCI) agreed to participate in the study and reported to the laboratory for 2 separate visits.

During session 1, patients underwent autonomic testing and performed an upper body ergometer graded exercise test (GXT). Autonomic function was assessed by sympathetic skin response (SSR), which used progressively increasing electrical stimuli (12-20mA) until a motor response was elicited (8), and orthostatic hypertension (OH) was assessed by the sit up test. Time to motor response for the SSR was used to determine severity of autonomic dysfunction (8). OH was defined as ≥20 mm Hg or ≥10 mm Hg drop in systolic or diastolic blood pressure following the shift in body position for the sit up test. For the GXT, all patients cycled on an arm ergometer at 50 $r \cdot min^{-1}$ with increasing workload until the participant's cycle cadence fell below 40 $r \cdot min^{-1}$. Expired gas was collected during the GXT to determine peak VO_2.

For session 2, each patient performed two 15-min bouts of upper body cycling at 50% peak VO_2 with a 2-min rest between each bout. During the cycling ECG, blood pressure, skin temperature (measured at 10 sites), T_{INT} (measured via telemetric pill), and T_{ESO} (measured by esophageal probe) were continuously monitored. Telemetric pills were ingested 8 to10 h prior to the exercise session and the esophageal probe was inserted through the right nostril and placed at the level of the right atria. Heat storage was calculated by using skin temperature and T_{INT} or T_{ESO} measures.

Baseline testing demonstrated that patients with tetraplegia had an absence of SSR and were positive for OH, where paraplegic patients maintained SSR of the upper limbs while none tested positive for OH. As anticipated, all control patients had a normal SSR and 1 control tested positive for OH. For exercise responses, men with SCI both had significantly lower peak VO_2 and workload when compared to control patients during the GXT as well as both bouts of arm cycling.

At rest, there were no significant differences in T_{INT} or T_{ESO} between groups. T_{ESO} had a significantly lower temperature at rest compared to T_{INT}. T_{ESO} and T_{INT} measures showed consistent rise in temperature between the paraplegic and control groups when comparing baseline to the 2 exercise bouts. There was no change in T_{ESO} and T_{INT} for the tetraplegic group. T_{ESO} temperatures began rising ~7 min earlier in both exercise bouts when compared to T_{INT}. There was no increase in skin temperature from baseline in any of the groups for either bout of exercise. The tetraplegia group had a time x group interaction with a reduction in forearm temperature as time progressed in each bout of exercise. Heat storage only increased when estimated from T_{ESO} for the paraplegic and control groups in the first 15-min bout of exercise. For the second bout of exercise, only the paraplegic group had a heat storage increase when compared to the first bout of exercise.

CLINICAL IMPLICATIONS

Results of the study confirm that persons with SCI have difficulty with thermoregulation when compared to non-SCI patients. With regard to monitoring core temperature, both T_{ESO} and T_{INT} responded similarly in the paraplegic and non-SCI groups. Neither method was appropriate for measuring core temperature in persons with tetraplegia. For convenience of monitoring, the clinical exercise physiologist may consider measuring clients with paraplegia via telemetric pill, which are typically well tolerated and inexpensive as compared to other methods. This is especially important when exercise takes place in an environment that may increase heat storage (e.g., GXT session or outdoor charity run/walk during hot and humid weather conditions).

Findings of this study are limited to men under controlled exercise intensities and laboratory climate. Further research is required to determine if the findings of this study are consistent with females, different age groups, and modes of exercise.

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