Ambulatory Blood Pressure Monitoring in Normotensive Individuals Undergoing Two Single Exercise Sessions. Resistive Exercise Training and Aerobic Exercise Training

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Objective - *To assess the influence of 2 single exercise sessions on blood pressure in sedentary normotensive individuals: one of resistive exercise training (circuit weight training) and the other of aerobic exercise training.*

Methods - *Using ambulatory blood pressure monitoring, this study assessed 25 individuals as follows: in a controlled situation at rest (ABPM 1); after resistive exercise training (ABPM 2); and after aerobic exercise training (ABPM 3). Resistive exercise training was performed as circuit weight training with an intensity of 40% of each individual's maximum strength. The aerobic exercise training was performed on a cycloergometer with intensity between 60% and 70% of the maximum heart rate (HR) reached during previous exercise testing.*

Results - *Systolic blood pressure (SBP) values during 24 hours and during subperiods of wakefulness and sleep showed no statistically significant variations when the results obtained at rest were compared with those of ABPM2 and ABPM3, and when the results of ABPM2 were compared with those of ABPM3. The mean heart rate during 24 hours and in the wakefulness period showed significant increases (P<0.05), when ABPM2 was compared with ABPM3.*

Conclusion - *A single session of resistive exercise training in normotensive individuals was sufficient to cause significant reductions in blood pressure levels after exercise in the period of sleep. The session of aerobic exercise training in these same individuals was more effective in significantly reducing blood pressure levels.*

Keywords: ABPM, resistive exercise, aerobic exercise

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English version by Stela Maris C. e Gandour
Received: 10/23/02
Accepted: 03/10/03

Several studies about the relation between blood pressure (BP) levels and physical exercise have mainly concentrated on exercise of the dynamic aerobic type [1-9], ie, continuous exercises, requiring a prolonged period of time and involving great groups of muscles. Aerobic exercises have been recognized as the most recommended when the issue is health promotion. Although they have successfully served this purpose, greater emphasis has been given to the practice of resistive exercise with the same objective [10,11]. Resistance or resistive training consists of local muscle work with overloads, such as weights, bars, and clamps, performed with moderate weights, frequent repetitions, and pauses, being, therefore, characterized as a discontinuous exertion.

Researchers have tried to better clarify the importance of resistive exercise in blood pressure variation [12-18]. The physical quality involved in this type of physical effort is muscle strength, which, in addition to being necessary to the development of athletic activities, is, in terms of health promotion, an essential parameter for the practice of occupational and leisure activities, contributing to the self-sufficiency of sedentary, elderly, hypertensive individuals, and those with heart diseases as well [17-19]. Currently, resistive exercises have been used in cardiac rehabilitation programs, promoting, when practiced under appropriate supervision, significant benefits and low risks [10], contributing to the reduction in resting blood pressure. In a meta-analysis with normotensive and hypertensive individuals [11], dynamic resistance exercise has been reported to cause a mean 3% reduction in systolic blood pressure (SBP) and a 4% reduction in diastolic blood pressure (DBP) in both groups, with no change in body weight and in resting heart rate. However, the mere fact that mild to moderate resistive exercise does not cause chronic elevations in blood pressure values is, in itself, significant, because physical qualities, such as, muscle strength or localized muscle resistance, or both, are essential to the development of routine activities, justifying the use of this type of exercise for improving physical fitness.

Some studies have shown that acute physical exercise

(1 single exercise session) is sufficient to cause a reduction in blood pressure during the period of exercise recovery, both in normotensive and hypertensive individuals [20-38]. The acute effects occur prior to and immediately after physical exercise. Late effects are observed within the first 24 hours following an exercise session and may be identified as the mild reduction observed in blood pressure levels, especially in hypertensive individuals. This means that the blood pressure levels observed in the period of exercise recovery are lower than those observed prior to exercise, or even those observed in a control day without physical exercise [24-35,37,39]. After acute physical exercise, this reduction in blood pressure (SBP or DBP, or both) to values below control levels (pre-exercise) is called acute postexercise blood pressure response. Some factors, such as initial blood pressure levels and type and duration of exercise, may influence the magnitude and duration of blood pressure response. For this reduction to be clinically important, it needs to have a significant magnitude and to last a long time after exercise [40].

A recent study [41] confirmed the clinical relevance of acute exercise, because the drop in blood pressure levels lasted 24 hours after a session of aerobic physical exercise. The drop in blood pressure has also been shown to be independent of exercise intensity.

The acute responses of blood pressure triggered by physical exercise for as long as 90 minutes right after an exercise session have been studied with conventional measurements [25,26,28,30,37,38] or with continuous blood pressure monitoring during the 24 hours following the session [34,36]. Most studies carried out so far have been based on blood pressure measurements at rest with casual recordings, which, as already known, may be influenced by different variables, such as circadian rhythms, and physical and mental activities [42,43].

A methodological advance to be considered in this study is the use of ambulatory blood pressure monitoring (ABPM) to assess the acute effects of resistive and aerobic exercises on blood pressure and heart rate. We analyzed the few studies using ABPM after a single session of resistance or aerobic exercise, or both, reported in the literature and their controversial results. Our study assessed the influence of 2 single sessions of resistive (circuit weight training) and aerobic exercise training on changes in blood pressure and heart rate in a group of sedentary normotensive individuals using the ABPM technique and compared the results obtained with the 2 types of exercise.

Methods

The study sample comprised 25 male, sedentary, nonsmoking, asymptomatic, normotensive (SBP < 140 mmHg and DBP < 90 mmHg) individuals aged 40 to 50 years (mean of 44±1 years). The study protocol was approved by the committee on medical ethics of the Biomedical Center of the Federal University of Espírito Santo, and the individuals provided written consent to participate in the study. All participants were assessed in regard to weight, height, and body mass index (BMI = body weight/height^2).

Before beginning the study, all volunteers took part in an "adaptation week" to get used to the exercises and to the laboratory environment. They also received an explanation about the monitoring technique. After that, all volunteers underwent exercise testing and the test to assess the maximum isotonic strength in an appropriate device. Later, individuals' blood pressure levels were monitored in a control situation (at rest, with no exercise), in a resistive exercise training session, and in an aerobic exercise session, which were randomly defined. Initial ambulatory blood pressure monitoring (ABPM1) was performed after the individuals had rested sitting for 5 minutes; on that day, they did not exercise. Ambulatory blood pressure monitoring after resistive exercise (ABPM2) and after aerobic exercise (ABPM3) were then performed. The interval between ABPM1 and ABPM2 was 48 hours; the same interval was observed between ABPM2 and ABPM3. The monitors were installed on the individuals approximately 20 minutes after the end of the exercise session, and maintained for 24 hours.

Exercise testing was performed on a treadmill (KT-10200 model, Inbramed) with electrocardiographic recordings at rest, prior to exercise in the 12 conventional leads, and in the MC5, V2, and modified D2 leads with the patients lying down and standing, in deep inspiration, and after 15 seconds of hyperpnea. The system of continuous electrocardiographic recording and the values of heart rate were followed up with a 3-channel monitor (SM400 model, TEB). The test was of the continuous type (Bruce treadmill protocol). Blood pressure and heart rate were measured at rest (with the patient lying down or standing) and at the end of each stage. During recovery, measurements were taken up to 4 minutes after physical exertion. Tests were performed until exhaustion was reached, and the maximum heart rate was that obtained at the last stage of the test. Only individuals with normal tests [44] were included in the study protocols.

All individuals underwent ABPM with a SpaceLabs monitor (90207 model), which uses the oscillometric technique for blood pressure measurement, allowing automate/manual recording of blood pressure and heart rate during 24 hours. The device was programmed to obtain the measures every 15 minutes from 6 AM to 10 PM and every 60 minutes from 10 PM to 6 AM. Monitoring was initiated at the beginning of the morning on the control day and on the days after exercise. Considering that not everybody had the monitor placed exactly at the same hour, we chose, based on the literature [45,46], to analyze the curve from 0 to 24 hours, considering 0 the moment of monitor placement. The recordings were considered valid for interpretation when 80% or more measurements obtained were valid. The individuals were required to maintain their usual daily activities during the period of readings and recommended to maintain, whenever possible, the nondominant upper limb surrounded by the cuff in a relaxed position during every measurement. A journal was provided for the patients to report their daily activities in detail (sleep, work, leisure, meals). Because the specific ABPM monitor program has restricted programming in regard to the times of the sleep-wakefulness cycle, and considering that each individual has his own pattern of sleep-wakefulness, the blood pressure and heart rate measures were calculated based on the times provided by each individual when filling out his journal. The rules for interpreting the results were defined by the III Brazilian Consensus for the use of Ambulatory Blood Pressure Monitoring [47]. The final report was obtained with SpaceLabs software.

To find the maximum load with which the individual could only perform 1 exercise repetition, the maximum strength was assessed with exercises involving the following muscle groups: latissimus dorsi, pectoralis major, biceps brachii, triceps brachii, biceps femoris, and quadriceps femoris. For each exercise, a maximum of 3 attempts were allowed. The test of maximum load was not performed for exercises involving the following muscle groups: right and left gluteal, abdominal, and dorsal-lumbar muscles. The exercises performed in this test were the same as those in the circuit weight training to be implemented, which corresponded to the same muscle groups assessed. Before undergoing this test, the individuals were acquainted with the equipment and exercise protocols, which allowed their adaptation to exercises, aiming at ruling out the influence of these variables on the test and obtaining a more appropriate result with the type of assessment to prescribe the intensity of the workout also used by other authors [13,14,17].

The individuals underwent 2 single exercises sessions: 1) 1 session of circuit weight training (resistive exercises), consisting of 3 complete series of 10 exercises each, with 20 to 25 repetitions (mean of 23), performed in a moderate and continuous rhythm with an estimated intensity of 40% of the maximum load (test of 1 maximum repetition - 1MR), each exercise lasting 45 seconds on average, with 30-second intervals between each exercise and 2-minute intervals between each series; and 2) 1 session of aerobic exercise on a cycloergometer (Biocycle Magnetic 2500, Movement) with an intensity between 60% and 80% of the maximum heart rate reached during exercise testing, and a velocity between 60 and 65 rpm, comprising 45 minutes of continuous activity. This session was preceded by a 5-minute warm-up on a bicycle without resistance and an equal period of recovery with the individual seated at rest. Warm-up and relaxation exercises were performed respectively before and after each exercise session.

For comparing the 2 means, ie, the value before and after a certain exercise in the same group, the Student *t* test was used for paired samples. For analyzing the hourly variations in ABPM in the same group, the 1-way analysis of variance (ANOVA) was used for repetitive measures, followed by the Tukey test to identify the points of significance in the curve. For analyzing the differences in the values of the temporal curves in the 3 groups studied, the 2-way ANOVA was used for repetitive measures, followed by the Tukey test. The results were expressed as mean ± standard error of the mean (SEM), and the significance level adopted was $P < 0.05$.

Results

Age and the anthropometric and cardiovascular data are shown in table I, where the individuals studied are shown as having similar characteristics and as being normotensive at rest.

Table II shows the values of the maximum isotonic strength in the test of maximum load assessment (test of 1 maximum repetition – 1MR) and the intensity of 40% of the maximum load (1MR) in the circuit weight training. The different types of exercises used for obtaining the maximum load and the workout load are also shown in table II.

During the single sessions of resistive and aerobic exercises, heart rate was monitored with the POLAR monitor (Accurex model) to quantify the intensity of the exercise. This measure allowed us to verify that the individuals exercised at a mean intensity of 68% and 65% of the maximum heart rate obtained in the exercise test in the circuit weight training (resistive exercises) and aerobic exercise sessions, respectively. The variations in heart rate during the single exercise sessions were within prescribed values, ie, 60% to 80% of the maximum heart rate obtained in the exercise test according to the recommendations of the American College of Sports Medicine [48].

The ambulatory blood pressure measures were of good quality with 69 valid measures and a 95% rate of success. Table III shows the mean values of blood pressure and heart rate obtained during 24 hours, during wakefulness and

Table I - Age, anthropometric, metabolic, and cardiovascular characteristics

Characteristics	Values
Anthropometric	
N	25
Age (years)	44 ± 1
Weight (kg)	69 ± 2
Height (m)	1.71 ±0.02
BMI (kg/m^2)	23.6 ±0.5
VO_2 max (mL/kg/min)	41.7 ±1.7
Cardiovascular at rest	
SBP lying (mmHg)	117 ± 2
DBP lying (mmHg)	73 ±1.5
HR lying (bpm)	70 ±1.8
Cardiovascular pre-exercise	
SBP standing (mmHg)	116 ±2.2
DBP standing (mmHg)	78 ±1.9
HR standing (bpm)	79 ±2.3

Values expressed as mean ± SEM; BMI- body mass index (weight/height^2); VO_2 max (maximum oxygen consumption); SBP- systolic blood pressure; DBP- diastolic blood pressure; HR- heart rate (bpm).

Table II - Exercise types, data of maximum load and workout load in circuit weight training (resistance)

Exercises	Maximum load (kg)	Workout load (kg)
Pull down	25 ± 1.1	10 ± 0.5
Leg press	142 ± 5.5	57 ± 2.2
Biceps curl	32 ± 0.8	13 ± 0.3
Knee curl	21 ± 0.8	8.4 ± 0.3
Bench press	34 ± 1.4	14 ± 0.5
Triceps pushdown	26 ± 0.6	10.4 ± 0.2

Values expressed as mean ± SEM.

sleep. The values obtained for blood pressure during 24 hours, wakefulness and sleep were normal before and after exercises. The resistive exercise caused a mild but significant increase in heart rate during 24 hours and wakefulness, and an increase in blood pressure during sleep; the aerobic exercise caused a significant reduction in blood pressure with no change in heart rate.

Figures 1, 2, and 3 synthesize, respectively, the means of SBP, DBP, and heart rate. The variations in SBP (figs. 1a and 1b) were not statistically significant. The means of DBP (figs. 2a and 2b) showed significant reductions (P<0.05) when the control measures were compared with those obtained after the aerobic exercise. During sleep, when the control measures were compared with those after resistive exercise and with those after aerobic exercise, reductions of 5% and 5.3% (P<0.01) were respectively obtained.

The means of heart rate (figs. 3a and 3b) showed a significant increase of 2.5% (P<0.05) in the 24 hours and in the wakefulness period when the measures obtained after resistive exercise were compared with those obtained after aerobic exercise.

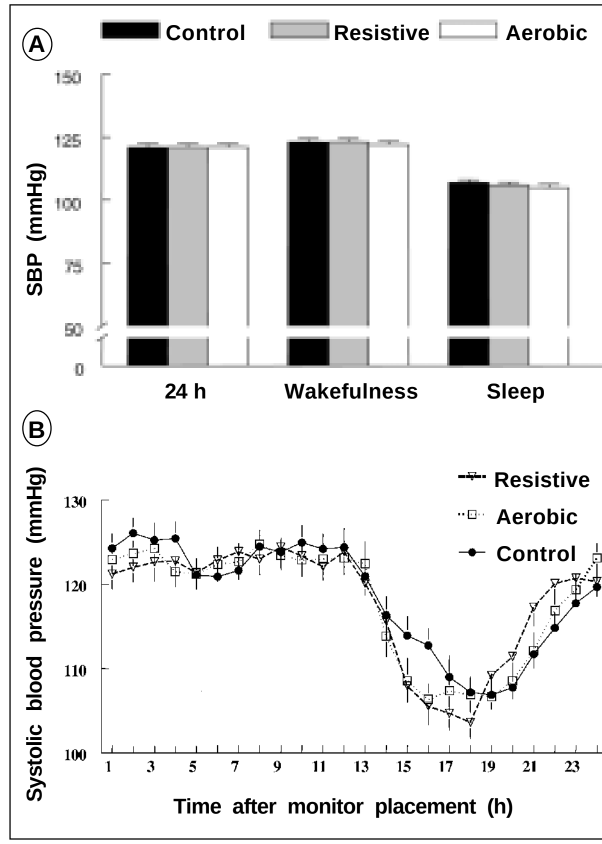

Fig. 1: A - Means of SBP obtained with ABPM. Control ABPM vs postresistive exercise ABPM; control ABPM vs postaerobic exercise ABPM; and postresistive exercise ABPM vs postaerobic exercise ABPM; 1B - Temporal evolution of systolic blood pressure values after placement of the ABPM monitor. The differences were significant when comparing control vs resistive and control vs aerobic at the times 15 and 16 hours. Between resistive and aerobic, a significant difference at the time 21 hours was observed.

Discussion

Most studies [20-23,27,30-33,35-39] have shown that acute aerobic and resistive physical exercises cause a long-lasting blood pressure drop during exercise recovery, ie, cause a reduction in blood pressure after exercise. The magnitude and duration of this blood pressure drop may be clearly influenced by several factors, such as the sample studied (normotensive or hypertensive individuals), and the type, intensity, and duration of exercise [40].

This study assessed, in the same group of individuals, the effect of appropriately standardized acute exercise, both in circuit weight training (resistance exercise) and acute aerobic exercise, on the behavior of blood pressure and heart rate during usual activities. For this, ABPM was used, allowing the assessment of the behavior of these hemodynamic variables over 24 hours.

Table III - Blood pressure (BP) and heart rate (HR) values obtained in control, postresistive exercise, and postaerobic exercise ambulatory blood pressure monitoring (ABPM)

Parameters	Control	Resistive	Aerobic
N	25	25	25
Mean 24 h			
SBP (mm Hg)	121 ± 1.3	121 ± 1.3	121 ± 1.3
DBP (mm Hg)	79 ± 1	78.3 ± 1	77.6 ± 1 ♦
HR (bpm)	77 ± 1.8	78.6 ± 2 ⊗	76.5 ± 1.7
Mean wakefulness			
SBP (mm Hg)	123 ± 1.4	123 ± 1.4	122 ± 1.3
DBP (mm Hg)	80.6 ± 1	79.6 ± 1.1	78.9 ± 1.1 †
HR (bpm)	78.4 ± 1.9	80 ± 2.1 §	77.6 ± 1.7
Mean sleep			
SBP (mm Hg)	107 ± 1,1	106 ± 1.1	105 ± 1.3
DBP (mm Hg)	66.4 ± 0.8	63 ± 0.9 *	62.9 ± 1.1 ‡
HR (bpm)	64.7 ± 1.4	64.6 ± 1.7	63.3 ± 1.4

Values expressed as mean ± SEM; SBP- systolic blood pressure; DBP- diastolic blood pressure, values in mmHg; *P<0.01 indicating significance (control ABPM vs postresistive exercise ABPM); †P<0.05 and ‡P<0.01 indicating significance (control ABPM vs postaerobic exercise ABPM); and §P<0.05 indicating significance (postresistive exercise ABPM vs postaerobic exercise ABPM); *t* test for paired samples.

Little emphasis has been given to cardiovascular parameters after a single session of resistive exercise [49]. In regard to acute exercises of the aerobic type, some studies [24,34,36] have used the ABPM technique after a single exercise session.

Recent studies [7,9,48,50] have focused on ABPM because it allows blood pressure measurements at predetermined intervals, during routine activities and sleep, providing a curve representing an individual's blood pressure behavior during 24 hours. Therefore, an important distinction exists between the present study and most studies in the literature [22,25,28,30,37-39]: while other studies have dealt with aerobic and resistive exercises individually through conventional blood pressure measurement or ABPM, in our study, the individuals underwent both exercises, which were compared during 24 hours and assessed through ABPM with blood pressure recordings during usual activities, in wakefulness and sleep. This procedure has rarely been used after exertion [24,34,36].

In regard to blood pressure response after 1 single session of aerobic exercise, our results are not in accordance

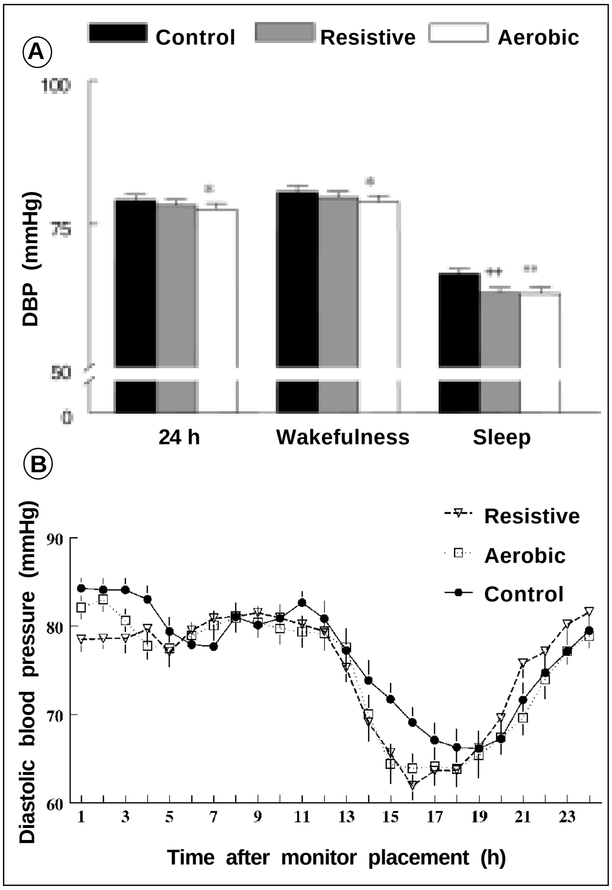

Fig. 2: A - Means of DBP obtained with ABPM. $^{++}P<0.01$ indicating significance control ABPM vs postresistive exercise ABPM. $^{*}P<0.05$ and $^{**}P<0.01$ indicating significance control ABPM vs postaerobic exercise ABPM; 2B - Temporal evolution of the systolic blood pressure values after placement of the ABPM monitor. The differences were significant when comparing control vs resistive at the times 1, 2, 3, 14, 15, and 16 hours, and control vs aerobic at the times 4, 15, and 16 hours. Between resistive and aerobic, a significant difference was observed at the times 2 and 21 hours.

with those in the literature, because most studies [20,28,35,36,51] have found significant reductions in SBP, ranging from 3 to 9 mmHg, in normotensive individuals. However, our results support those of other studies [24,26], in which no drop in SBP was observed in normotensive individuals. Pescatello et al[24], assessing normotensive and hypertensive individuals, measured the response of ambulatory blood pressure to different intensities of acute aerobic exercise for 13 hours after exertion; those authors found no reduction in blood pressure in normotensive individuals, but significant reductions in SBP (5 mmHg) and in DBP (8 mmHg) in hypertensive individuals. In regard to the mean values of SBP after a single session of resistance exercise, our results confirm those of other authors [28,39,47,50], who also found no significant reduction in SBP in normotensive individuals.

In regard to the DBP response after 1 single session of aerobic exercise, our results are in accordance with those of other studies [30,35,51,52], which found significant reductions in DBP ranging from 2 to 6 mmHg; however, our results are contrary to those of other researchers [20,28], who found no significant reduction in DBP in normotensive individuals. Our results also support another study [36], in which a significant decrease in DBP (2 mmHg) after acute aerobic exercise,

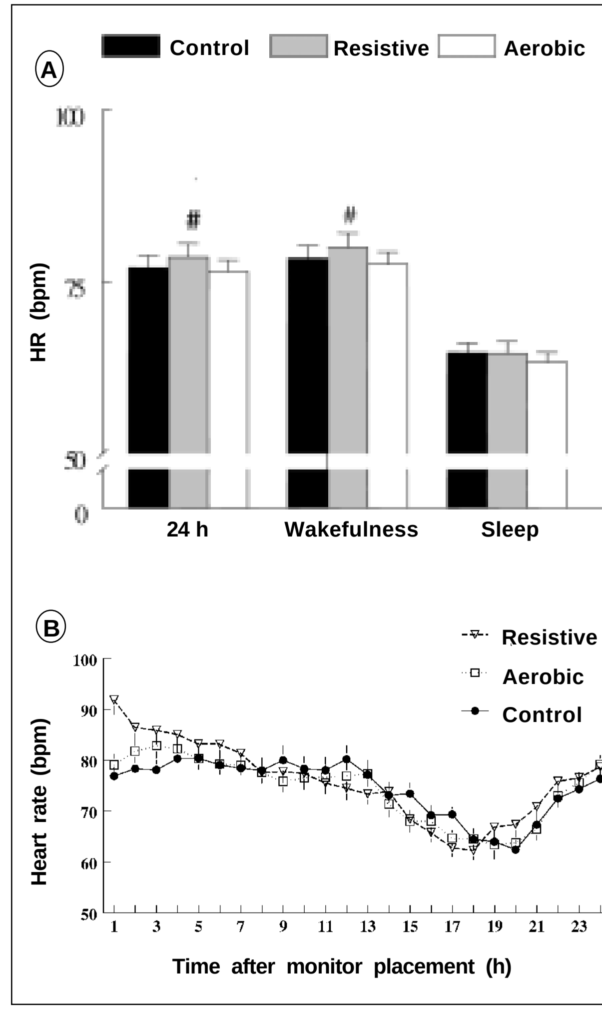

Fig. 3: A - Means of HR obtained with ABPM. #P<0.05 indicating significance postresistive exercise ABPM vs postaerobic exercise ABPM; 3B - Temporal evolution of the heart rate values after placement of the ABPM monitor. The differences were significant when comparing control vs resistive at the times 1, 2, 3, 12, and 17 hours, and control vs aerobic at 15 hours. Between resistive and aerobic, a significant difference was observed at 1 hour.

persistent for 24 hours, seemed to predominate during sleep. However, in regard to the wakefulness period, that same study found no significant variation in DBP, while our study found a significant reduction in DBP during the same period. We believe that the reductions found in DBP in 24 hours and during the wakefulness and sleep periods have relevant clinical significance.

Hill et al [51], studying normotensive individuals aged 22 to 33 years after resistive exercise with a 70% intensity, 1MR, and mean duration of 14 minutes, have reported a significant (8 mmHg) drop in DBP. Brown et al [33] have reported no significant drop in DBP after a session of low intensity muscular resistance. Other authors [39] have reported that after 50% of voluntary maximum load, DBP significantly dropped. In our study, a reduction in DBP was observed during sleep after resistance exercise, which is not in accordance with the results of another study [28], which concluded that no drop in blood pressure occurred after 1 single session of resistive exercise.

Studies carried out with normotensive individuals [24] reported lower values of blood pressure before exercise (control) in those individuals, and that the absolute difference in the exercise recovery was smaller than that found in hypertensive individuals, and, therefore, less likely to reach statistical significance.

Reports in the literature on heart rate behavior during exercise recovery have been controversial. Rueckert et al [34], studying hypertensive individuals of both sexes, report that after a session of aerobic exercise, heart rate was significantly increased in the 3 hours following exercise. Those authors suggest that tachycardia, maintained during the exercise recovery period, could be caused by a baroreflex mechanism influenced by blood pressure drop or a postexercise reduction in vagal activity with exacerbation of the sympathetic activity for the heart, according to other authors [30]. Other studies have reported no changes in heart rate [21,22,24,36]. Changes in heart rate after physical exercise have also been reported [38], and the differences seem to be related to the intensity of the exercise, because the authors observed the following: after 45 minutes of mild aerobic exercise (30% of maximum oxygen consumption), a drop in heart rate is observed; after moderate exercise (50% of maximum oxygen consumption), an increase is observed; and after more intense exercise (80% of maximum oxygen consumption), a transient increase is observed.

Several studies in the literature [53-58] have considered heart rate measurement as 1 more parameter to analyze the behavior of the cardiovascular variables obtained through ambulatory monitoring during 24 hours. Our results show a significant increase (2.5%) in mean heart rate during 24 hours and in the wakefulness period when ABPM after resistive exercise was compared with ABPM after aerobic exercise; on the other hand, no statistically significant difference was observed when control monitoring was compared with ABPM after aerobic exercise and after resistive exercise. Our results corroborate those of other researchers[24], who found no significant differences in the heart rate of normotensive individuals before and after 1 single session of aerobic exercise. This has also been reported in another study [47] in which heart rate significantly increased after 1 single session of resistive exercise.

Greater means of heart rate were observed in the 24-hour curve obtained every hour after monitor placement when control ABPM was compared with ABPM after resistive exercise. However, these significant increases were isolated and occurred in the 3 hours following exercise. No upward displacement of the curve was observed. Our results corroborate those of O'Connor et al [49] who reported that heart rate after 1 single session of resistance exercise significantly increased in the 2 hours following exercise. Because ABPM is not the best choice for heart rate assessment, future studies require another methodology for the obtainment of less controversial data regarding that parameter.

Several authors have tried to explain the mechanisms involved in blood pressure reduction during the exercise recovery period. The drop in blood pressure during exercise recovery may be mainly due to the reduction in total peripheral vascular resistance [25,30,31,34,35]. This reduction may be related to the vasodilation caused by physical exercise in both active [34,35] and inactive [25,26,31] musculature. Piepoli et al[31] have reported that vasodilation in inactive muscles may be related to exercise intensity. Hagberg et al [32] have shown that the reduction in cardiac output is the mechanism responsible for blood pressure reduction after physical training. Through the technique of CO_2 reinhalation and balance, those authors observed that blood pressure drop after a period of physical training was associated with a reduction in cardiac output due to bradycardia at rest, because no significant changes in systolic volume were observed [32]. In a recent study with nonobese hypertensive elderly individuals, Rondon et al [59] reported that the postexercise reduction in blood pressure was associated with a drop in left ventricular final diastolic volume, and, consequently, in systolic volume, and in cardiac output. The following mechanisms have also been proposed: thermoregulatory mechanisms [27]; an increase in muscle blood flow as a probable consequence of the reduction in the peripheral sympathetic activity [25,60]; direct modulation of endogenous opioids upon blood flow, increasing peripheral vasodilation [61]; changes in the functioning of arterial baroreceptors [22] and cardiopulmonary receptors [26] of volume, such as an increase in their sensitivity and alteration in the point of adjustment of these reflexes in exercise recovery, which may contribute to the postexercise vasodilating effect. Rueckert et al [34] have reported that the postexercise blood pressure reduction was determined by a biphasic mechanism, ie, it depended on the drop in peripheral vascular resistance in the initial 30 minutes of recovery and on the drop in cardiac output after that period. Therefore, the mechanisms responsible for blood pressure reduction after exercise remain controversial, and may be related, in addition to other factors, to the reduction in cardiac output or in peripheral vascular resistance.

Some studies [39,62] have also assessed the mechanisms related to the reduction in stress and anxiety after exercise, suggesting that the ansiolytic effect of both aerobic and resistance exercises may play an important role in blood pressure decline after exercise. It is worth emphasizing, however, that the mechanisms involved in the genesis of blood pressure reduction were not an object of our investigation.

Our results confirm that 1 single session of resistive exercise was effective in causing a significant reduction in blood pressure levels after exercise in normotensive individuals during sleep when assessed with ABPM. In addition, the single session of aerobic exercise was more effective in causing significant blood pressure reductions in these same individuals, considering that reductions in blood pressure occurred after exercise in 24 hours and in the wakefulness and sleep periods. However, these individuals' heart rates were elevated during 24 hours, in the wakefulness period, and during acute resistive exercise recovery.

This issue requires further clarification for the establishment of the role played by acute physical exercise in blood pressure modulation. The contribution of ABPM will certainly represent an advance for future studies.

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