

Changes in resting heart rate and blood pressure in response to resistance exercise training program

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ABSTRACT

Angelheart Joy Maynard Rattu - *Changes in resting heart rate and blood pressure in response to resistance exercise training program*

Background: Previous studies showed that both systolic and diastolic blood pressures could be lowered to a modest degree with an aerobic type exercise.

Objective: The present study was designed to explore the effect of resistance exercise training program on resting heart rate and blood pressure in males and females.

Methods: Thirty-three normal healthy subjects participated in this study. Resting heart rate and resting blood pressure were measured before and after a weight-training program twice a week for eight weeks.

Results: Data showed that resting heart rate was significantly (p) lower in males compared to that observed in females before and after the training program. A significant decrease in resting heart rate (p) was observed in both sexes as a result of the training program. Resting systolic and diastolic blood pressures were slightly ($p=0.08$) lower in the female group compared to that observed in the male group before the training program. Resistance exercise training induced no significant change in resting systolic and diastolic blood pressures in both groups. After the training program, resting systolic and diastolic blood pressures were slightly ($p=0.09$) lower in the female group compared to that observed in the male group.

Conclusion: Exercise stimulus in the form of circuit weight training was sufficient to elicit cardiovascular adaptations in response to training.

Key words: resistance exercise training - heart rate - systolic and diastolic blood pressures - cardiovascular adaptations

ABSTRACT

Angelheart Joy Maynard Rattu - *Perubahan denyut nadi istirahat dan tekanan darah istirahat setelah program latihan beban*

Latar belakang: Penelitian-penelitian terdahulu telah membuktikan bahwa tekanan darah sistolik dan diastolik dapat diturunkan melalui suatu program olahraga aerobik.

Tujuan: Penelitian ini dirancang untuk mengetahui pengaruh latihan beban (latihan melawan tahanan) terhadap denyut nadi istirahat dan tekanan darah pada pria dan wanita.

Bahan dan cara penelitian: Tiga puluh tiga orang coba sehat berpartisipasi dalam penelitian ini. Denyut nadi istirahat dan tekanan darah istirahat diukur sebelum dan sesudah suatu program latihan beban yang dilakukan dua kali seminggu selama delapan minggu.

Hasil penelitian: Data menunjukkan bahwa pria memiliki denyut nadi istirahat jantung yang lebih rendah (p) dibanding wanita, sebelum dan sesudah program latihan beban. Penurunan denyut nadi secara bermakna (p) ditemukan pada pria dan wanita sebagai respons terhadap program latihan beban. Tekanan darah sistolik dan diastolik sedikit lebih rendah ($p=0,08$) pada wanita dibanding pria sebelum program latihan. Tekanan darah istirahat pada pria dan wanita tidak berubah secara bermakna setelah program latihan beban. Setelah program latihan, tekanan darah sistolik dan diastolik pada wanita sedikit lebih rendah ($p=0,09$) dibanding pria.

Simpulan: Rangsangan latihan dalam bentuk sirkuit latihan beban sudah cukup untuk menimbulkan suatu adaptasi jantung-paru terhadap latihan.

INTRODUCTION

The health benefits of regular exercise have long been recognized. As early as 1899, physicians recommended that physical activity could protect against deep venous thrombosis post-operatively¹. In this century, numerous scientists have linked regular exercise to lower risk of coronary heart disease and cancer and increased longevity^{2,3}. Although the mechanisms by which exercise reduces cardiovascular risk are not as yet entirely known, exercise usually induces favorable alterations in blood lipid profiles^{4,5}. It has also been postulated that exercise may result in favorable changes in blood coagulation and fibrinolysis^{6,7}. Although the degree to which regular exercise can benefit a hypertensive condition is still unclear, it does appear that both systolic and diastolic blood pressures can be lowered to a modest degree with a program of aerobic type exercise^{8,9}.

Resistance exercise is becoming widely used and accepted, not only in sport training, but also in recreational and health-related exercise as well as occupationally related training activities. The physiological effects of resistance exercise on muscular strength have been extensively studied and widely reported¹⁰⁻¹¹. Little attention, however, has been devoted to explore the effect of this kind of exercise on resting heart rate and resting blood pressure. Therefore, the present study was designed to examine the effect of resistance exercise training program on resting heart rate and blood pressure in males and females.

MATERIALS AND METHODS

Subjects

Thirty-three (21 male and 12 female, 21.01.5 years) normal healthy subjects volunteered to participate in this study. Subjects had not previously participated in an organized weight-training program, but were involved in other sport activities both before and during the duration of the study. Experiments were carried out on males and females in an attempt to compare the physiological responses in both sexes. A general medical questionnaire was administered before and after resistance exercise training. Aethical

approval was obtained from the University Ethics Committee and an informed consent was procured from each subject before participation. All subjects participating in the exercise training were requested to maintain their normal diet. When subjects reported to the laboratory for testing, body mass and percentage body fat were determined. Percentage body fat was estimated from skinfold measurements as described by Durmin and Womersley.¹²

Measurement of resting heart rate and resting blood pressure

Subjects rested in the supine position for 15 min and heart rate was measured continuously during the last 5 min using a short range radio telemeter (SPORT TESTER 3000, Finland). Immediately after measurement of heart rate, systolic and diastolic blood pressures were assessed twice (5 min intervening) by means of a sphygmomanometer (ACCOSON FREESTYLE, England). The average of the two readings was employed in the statistical analyses of the data. Resting heart rate and resting blood pressure were determined before and after a weight training program.

Resistance exercise training program

Before the start of the main study a period of, 2-3 weeks was taken to familiarize every subject with the training protocol. All subjects exercised twice weekly for eight weeks. Subjects performed only the assigned training exercises prescribed in this study and engaged in no other exercise training programs. Two different sequences of exercises encompassing upper and lower body parts were used on an alternate basis. The sequence of exercises in the first profile was bench press, leg press, latissimus pull down, prone leg curl, shoulder press, leg extension, and standing biceps curl. In the second profile the sequence of exercises was shoulder press, leg press, latissimus pull down, leg extension, bench press, prone leg curl and standing biceps curl. Maximum strengths of major muscle groups for upper and lower body parts were determined before and after the training period using 15 RM. The 15-RM strength was determined for each exercise to obtain measures of maximum resistance exercise volume for the upper and

lower body parts. The 15 RM was defined as the maximum weight that could be lifted 15 times through the full range of motion employing the correct techniques¹³. Subjects were continuously encouraged to push themselves and increase both repetitions and the weight lifted. All workout were individually supervised and monitored for progress. When subjects improved in strength, weights were progressively increased to elicit 15 RM for each exercise. Rest periods interspaced exercises (30 second) and sets (120 second). Resistance exercise sessions were always preceded by 5-10 minutes warm-up and ended with a 5-10 minutes cool-down¹⁴. Adherence to the training program, defined as the percent of available training sessions attended, was 100%.

Statistical analyses

The statistical analyses of the data were carried out using analyses of variance (ANOVA) with repeated measurements. The dependent variables of heart rate and blood pressure were entered into 2 x 2 ANOVA models to detect differences between pre-post training and between male-female, respectively. A level of p was chosen to indicate significance.

RESULTS

TABLE 1 shows the mean values of body mass and estimated percentage body fat in males and females before and after the training program. Body mass was significantly (p) higher in males compared to that observed in females both before and after the training program. Resistance exercise training induced no significant change in body mass in males or females. Percentage body fat was significantly (p) higher in females compared to that found in males. This was found both before and after training. The statistical comparison of the mean values of the percentage body fat before and after training also revealed no significant differences in both males and females.

The results of resting heart rate and systolic and diastolic blood pressures in males and females before and after the training program are presented in TABLE 2. The mean value of the resting heart rate was significantly (p) lower in males compared to that observed in females

before and after the training program. A significant decrease in resting heart rate (p) was observed in both sexes (9%) as a result of the training program.

TABLE 1. – Body mass and estimated percentage body fat (mean±SE) in males (N=21) and females (N=12) before and after resistance exercise training.

		Before training	After training
Weight (kg)	Males	72.0 ± 1.5*	72.3 ± 1.7*
	Females	62.0 ± 2.0	60.7 ± 1.4
Body fat (%)	Males	15.4 ± 1.1*	16.2 ± 1.0*
	Females	27.2 ± 1.6	29.6 ± 1.7

*significantly (P) higher than that observed in females.
+significantly (P) lower than that observed in females.

TABLE 2. – Resting values (mean±SE) of resting heart rate and blood pressure in males (N=21) and females (N=12) before and after resistance exercise training.

		Before training	After training
Resting heart rate (beats.min ⁻¹)	Males	65 ± 1.1*	60 ± 1.5 [§]
	Females	73 ± 1.3	67 ± 1.8 [§]
Systolic blood pressure (mmHg)	Males	118.9 ± 2.6	121.6 ± 2.0
	Females	111.5 ± 2.9	115.0 ± 3.2
Diastolic blood pressure (mmHg)	Males	71.2 ± 2.0	73.5 ± 1.5
	Females	64.9 ± 1.8	70.0 ± 2.0

*significantly (P) lower mean value than that observed in females.
§significantly (P) lower mean value than that observed before training.

Resting systolic and diastolic blood pressures were slightly (p=0.08) lower in the female group compared to that observed in the male group before the training program. Resistance exercise training induced no significant change in resting systolic and diastolic blood pressures in male and female groups. After the training program, resting systolic and diastolic blood pressures were slightly (p=0.09) lower in the female group compared to that observed in the male group.

DISCUSSION

Resistance exercise training program and body composition

Body mass was significantly greater in males compared to that in females both before and after the conditioning program. Percentage body fat was significantly higher in females compared to that in males both before and after conditioning. These data are normal for such a population. The

resistance exercise conditioning program had no effect on body mass and percentage body fat in either males or females. This is in agreement with Wilmore et al¹⁵ who found no significant changes in body mass and percentage body fat in either sex after a 10-week circuit weight-training program encompassing 3 circuits of 10 stations, 3 days per week. The data also concur with the findings of Kokkinos et al¹⁶ who compared low and high-repetition resistance exercise training programs and found no significant changes in body mass and percentage body fat after 10 weeks of training. It should be noted, however, that Wilmore et al¹⁵ and Kokkinos et al¹⁶ found an increase in lean body mass in response to resistance exercise training. Other investigators¹⁷ found a decrease in percentage body fat in males and females after 16 weeks of weight-training. An exercise regimen in which a person works with greater intensity, for a longer duration per session, and for more sessions per week will produce a greater fat loss than a lesser exercise program¹⁷. The fact that the decrease in the percentage body fat was not statistically significant in the present study probably related to the duration of the training program which was only 8 weeks. Pollock¹⁸ stated that programs of 8 to 10 weeks duration generally result in less changes in body composition parameters compared to those of longer duration. However, this is not always the case. For example, Hurley et al¹⁹ failed to demonstrate a significant changes in body composition after 16-week high-intensity resistive training on 11 healthy untrained males.

Resistance exercise training program and resting heart rate

Resting heart rate values of the subjects who participated in the present study were within the normal range and those are usually reported in the literature for men and women. The mean value of the resting heart rate was significantly lower in males compared to that in females before and after the training program. The idea that resistance exercise training decreases resting heart rate has been widely reported^{13,20,21}. In the present study, resting heart rate decreased significantly in males and females after the resistance exercise training program. These results concur with those of Wilmore et al¹⁵

who found a significant decrease in resting heart rate in males and females after 10 weeks of circuit weight-training (from 64 to 58 b.min⁻¹ for males and from 65 to 59 b.min⁻¹ for females). In contrast, Harris and Holly²² reported no significant changes in resting heart rate in hypertensive subjects after 9 weeks of circuit weight-training. These contrasting results could be attributed to differences in the populations studied (normal subjects vs hypertensive patients) and exercise training programs (intensity and duration). The exact mechanism producing a resistance training-induced bradycardia is not known but it is probably related to both a reduced beta-adrenergic stimulation and/or an increase in parasympathetic receptor activity²³. Kanakis and Hickson²¹ and Fleck²¹ suggested that the decrease in heart rate resulting from weight-training is accompanied by an increase in stroke volume due to increased venous return.

Resistance exercise training program and resting systolic and diastolic blood pressures

Resting systolic and diastolic blood pressures data in males and females pre- and post resistance exercise training obtained in this study were within the normal limits. The present study showed no significant change in resting systolic and diastolic blood pressures in males and females after the training program. These findings are similar to those of Hurley et al¹⁹ who observed no significant changes in blood pressure after 16 week of high intensity strength-training in healthy subjects. Likewise, Ghilarducci et al²⁴ found no significant changes in blood pressure after 10 weeks of strength-training in 9 male cardiac patients. Unlike the present study, Stone et al²⁵ reported a significant decreases in resting systolic but no change in diastolic blood pressure after 8 weeks of Olympic style weight training in young men. Using young adult men and women in their 16 weeks of a weight training program, Goldberg et al²⁶ observed a decrease in both systolic and diastolic pressures at rest and during treadmill exercise while the subjects carried weights. The same phenomenon had also been observed in hypertensive subjects. For example, using moderately hypertensive male subjects, Harris and Holly²² observed a decrease in diastolic blood pressure after 9-weeks circuit

weight training program. Jennings et al²⁷ suggested that the decrease in blood pressure after exercise training was due to a decrease in total peripheral resistance as a consequence of a reduction in sympathetic activity and renin-angiotensin system activity at rest. The discrepant results reported above may be attributed to differences in subjects characteristics (healthy subjects vs patients), exercise training programs and methods used for blood pressure measurements in various investigations.

CONCLUSION

It was established that the program of the resistance exercise training conducted twice a week for eight weeks had no effect on body mass and percentage body fat in either males or females. The absence of significant change in body composition in the present study could be related to the intensity, frequency, or duration of the training program. Resting heart rate, but not blood pressure post training decreased significantly in males and females. This may suggest that exercise stimulus in the form of circuit weight training was sufficient to elicit cardiovascular adaptations in response to training.

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