

Arterial blood pressure in female students before, during and after exercise

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Abstract

BACKGROUND: Physical activity (PA) has been associated with reduced blood pressure in observational epidemiologic studies and individual clinical trials. Since PA is considered as a key component for the prevention and treatment of hypertension in children and adolescents, the purpose of this study was to assess blood pressure changes in athletic and non-athletic students before, during and after PA.

METHODS: The subjects in this experimental study consisted of 60 female athletic (n = 30) and non-athletic students (n = 30) with an average age of 21-23 years. The athletes were physical education students and non-athletes were medical students. Blood pressure (BP) at the right arm was measured in sitting position at 5 minutes before, 6 minutes after starting PA and 5 minutes after the end of the exercise. Weight, height, body mass index (BMI), mean arterial pressure (MAP) and pulse pressure (PP) were measured by ordinary methods. Data was analyzed using student's t- test. Results were expressed as mean \pm SD. The statistical difference was considered significant at $P < 0.05$.

RESULTS: The results showed that while systolic BP (SBP) increased during and 5 minutes after the end of physical exercise in both groups, diastolic BP (DBP) decreased. However, SBP values were significantly lower in non-athletic female students compared to the athletes. On the other hand, DBP values were significantly lower in athletic female students compared to non-athletes. Moreover, heart rate values were significantly lower at rest, during and 5 minutes after the end of physical exercise in athlete female students compared to non-athletes.

CONCLUSION: Our results revealed that physical activity reduced arterial BP levels in female athlete students.

Keywords: Physical Activity, Blood Pressure, Athletes, Non-Athletes.

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Introduction

There are two types of blood pressure (BP), systolic (SBP) and diastolic (DBP). DBP is determined mainly by cardiac output and peripheral vascular resistance.^{1,2} During an exercise, such as running, cycling, and swimming, cardiac output increases and peripheral vascular resistance decreases in response to vasodilatation of resistant arterioles within exercising skeletal muscles.² Research has shown that while SBP progressively elevates during exercise, slight elevation is seen in DBP.³ Fujikawa et al.,⁴ Fasting et al.,⁵ and Brett et al.⁶ reported gender, body mass index (BMI), smoking and physical activity to be associated with high BP. Whelton et al.⁷ and Howden et al.⁸ suggested

aerobic exercise to reduce blood pressure in both hypertensive and normotensive persons. Previous studies have indicated mean DBP to be higher in girls with low physical activity compared to more active females.⁹ In addition, dynamic exercise has been found to produce large, significant increases in SBP and moderate, yet significant, increases in DBP.¹⁰ Becker et al. showed that although SBP increased during exercise, DBP decreased.¹¹ Moreover, the extent of exercise has been indicated to be associated with lower prevalence of obesity and resting tachycardia in both sexes while it was slightly related with the prevalence of high SBP.^{12,13} Observational experiments showed that most medical students were

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physically fit and active. In addition, positive correlations have been found between prior exercise habits and performance on fitness tests which was in turn indicative of reduction of risk factors.¹⁴ Furthermore, a high correlation exists between risk factors for heart disease and measured BP.^{15,16}

Female medical students are believed to have lower rates of physical activity in comparison to female athlete students of physical education in Azad University in Zahedan, Iran. Therefore, the present study aimed to compare BP indexes in these two groups of students before, during, and after exercise activities.

Materials and Methods

Subjects:

This experimental study was carried out in Zahedan University of Medical Sciences and Zahedan Azad University, Zahedan, Iran. The test group included 60 female 18-23 year-old athlete students of physical education who volunteered to participate and were randomly selected.¹¹ They were all members of a sport team and had one hour of aerobic activity at least 3 times a week. Any kind of rhythmic exercise involving some large muscles was accepted.¹⁷ A group of 18-23 year-old volunteer female medical students ($n = 30$) were also randomly selected as controls. They had no experience of physical exercise and were not members of any sport teams. Both groups had no history of smoking, cardiovascular diseases, hypertension, drug therapy and diabetes.¹¹

Study Design:

Height and weight of all subjects were measured with light clothes on but without shoes by standard scales with readability of 3 cm and 500 grams, respectively. Heart rate was measured at the right arm by T AKSUN chronometer in sitting position. Mean arterial pressure (MAP) was calculated as the sum of DBP and pulse pressure (PP). PP was in turn calculated as SBP minus DBP. Body mass index (BMI) was determined as weight (kg) divided by height squared (m^2). All the participants received verbal and written

information about the purpose and procedures of the study before giving informed consent to participate. A questioner was then filled out by each participant. BP was measured at 8 and 11 A.M., and also at three phases of physical activities six minutes before, five minutes after start and five minutes after the end of training.^{11,17}

Blood pressure was measured three times from the right arm with a table sphygmomanometer (Germany Company Riester) and with medical Stethoscopes Riester. The cuff width measured approximately 3.2 of an arm's length and was appropriately fit according to the subject's size.¹¹ Korotkof phase I was used to defined systolic blood pressure (SBP) and phase V was used for the diastolic blood pressure.¹⁸ The mean of the three measured values was considered as BP for each individual.

Exercise started with running and continued for 10 minutes for all participants.¹⁹

Statistical tests:

The data was analyzed using student and paired-t tests in Statistical Package for Social Science (SPSS₁₀) and the results were shown as mean \pm SD. P values less than 0.05 were considered to be significant. The study was approved by the Research and Ethics committee of Zahedan University of Medical Sciences (Zahedan, Iran).

Results

According to measurements, the two groups were not significantly different in terms of height, weight and BMI (Table 1). Heart rate [expressed in beats per minute (bpm)] before exercise stress testing was significantly lower in athlete students compared with non-athletes (74 ± 4 vs. 76 ± 4 bpm; $P = 0.05$). It significantly increased in medical students compared to the athletes (126 ± 8 vs. 112 ± 7 bpm; $P = 0.001$) during exercise stress testing. The rising trend continued until 5 minutes after the end of exercise stress testing (77 ± 4 vs. 80 ± 4 bpm; $P = 0.01$) (Table 1).

The measured SBP values are shown in table 2. Statistical analysis showed a significant difference in

Table 1. t (max) and 5 minutes after exertion in athlete and non-athlete female students ($n = 60$)

	Athletes (mean \pm SD)	Non-athletes (mean \pm SD)	P
Height (cm)	169.5 \pm 5.2	169.9 \pm 4.9	> 0.05
Weight (kg)	60.4 \pm 6.5	59.7 \pm 5.3	> 0.05
BMI (kg/m^2)	21.1 \pm 1.3	20.8 \pm 1.1	> 0.05
HR rest (bpm)	74 \pm 4	76 \pm 4 a	> 0.05
HR max (bpm)	112 \pm 7	126 \pm 8 b	0.001
HR after (bpm)	77 \pm 4	80 \pm 4 c	0.010

All values are expressed as mean \pm SD

HR: heart rate, bpm: beats per minute

a = Heart rate rest, based on sample student T-test was lower in athletes compared with those of non-athletes; b = Heart rate max, based on sample t-test was lower in athletes compared with those of non-athletes; c=Heart rate 6 rest, based on sample t-test was lower in athletes compared with those of non-athletes

SBP values between medical and athlete students during and also after exercise training ($P < 0.01$ and $P < 0.001$, respectively). Significant differences were also found between medical and athlete students in DBP values measured at all three phases ($P < 0.001$, $P < 0.001$, and $P < 0.01$, respectively) (Table 2).

The data analyses indicated that MAP and PP values at maximal effort and 5 minutes after the exercise were significantly higher in athlete students than medical students ($P = 0.001$ and $P = 0.01$ for MAP and $P = 0.003$ and $P = 0.001$ for PP) (Table 3).

Discussion

Our results showed that based on the criteria described by Laswar et al.,¹¹ the two groups were not significantly different in terms of height, weight and BMI. In addition, although SBP increased in both athlete and non-athlete female students during exercise stress testing mean values of DBP at rest were significantly lower in athletes than non-athletes. DBP values also during and after exercise stress testing.

Due to significantly lower heart rates athletes, PP values were higher in athlete students compared to non-athletes. Moreover, increments in SBP and reductions in DBP were observed in both athlete and non-athlete female students. Similarly, Becker et al. investigated arterial blood pressure index alterations under physical exertion in healthy adolescents and reported an increase in SBP and a decrease in DBP in male and female adolescents before, during and after stress exercise testing.¹¹ Likewise, Becker et al.

showed that arterial blood pressure changed in adolescents in response to exercise stress testing and that during physical exercise SBP arose in individuals, but DBP dropped in all subjects.²⁰ Wright et al. also reported large, significant increases in SBP and moderate, yet significant, increases in DBP resulted by dynamic exercise.¹⁰ In contrast, Owen et al. found isometric exercises for less than an hour per week to reduce SBP by 10.4 mm/Hg and DBP by 6.7 mm/Hg. They thus suggested that an increase in aerobic physical activity should be considered as an important component of lifestyle modification for prevention and treatment of high BP.²¹ This may be due to differences in participants' age and methods employed in the two studies.

According to the results of the present study, heart rates were significantly higher before, during and after training in non-athletes (female medical students) compared to athletes (female physical education students). Uusitalo et al. also reported that aerobic training caused a decrease in heart rate in adults after 5 years of regular exercise.²² This reduction of the heart rate might have been caused by better heart function and a higher level of cardiovascular fitness in athletes.

The limitation of the present study was not measuring breathing frequency. In addition, we could not measure arterial blood gases in the two groups.

Conclusion

The present study showed that physical activity has the ability to decrease the arterial blood pressure index and heart rate in female athlete students.

Table 2. Systolic (SBP) and diastolic blood pressure (DBP) (mm/Hg) before, during (max) and 5 minutes after physical exertion in athlete and non-athlete female students (n = 60)

	Athletes (mean ± SD)	Non-athletes (mean ± SD)	P
SBP before	111±5.7	109.2±3.7	> 0.05
SBP max	154.8±5.9	145.5±5.6 a	< 0.001
SBP after	114.5±6.6	110.5±4.7 b	< 0.01
DBP before	75.9±3.1	78.6±2.9 c	< 0.001
DBP max	67.6±2.5	71.6±3.5 d	< 0.001
DBP after	77.3±2.8	79.7±3.9 e	< 0.01

All values are expressed as mean ± SD

a = Systolic blood pressure max based on sample t-test was higher in athletes compared with those of non-athletes; b = Systolic blood pressure 6 rest based on sample t-test was higher in athletes compared with those of non-athletes; c = diastolic blood pressure rest based on sample t-test was lower in athletes compared with those of non-athletes; d = diastolic blood pressure max based on sample t-test was lower in athletes compared with those of non-athletes; e = diastolic blood pressure 6 rest based on sample t-test was lower in athletes compared with those of non-athletes

Table 3. Mean arterial pressure (MAP) and pulse pressure (PP) (mm/Hg) at rest, maximal effort (Max) and 5 minutes after exertion in athlete and non-athlete female students (n = 60)

	Athletes (mean ± SD)	Non-athletes (mean ± SD)	P
MAP rest	109 ± 3.2	109.8 ± 1.5	> 0.05
MAP max	153.8 ± 7.1	142.8 ± 6.6 a	0.001
MAP after	113.6 ± 7.1	109.8 ± 4.6 b	0.01
PP rest	33.7 ± 3.8	30.2 ± 4.7 c	0.003
PP max	82.8 ± 7.7	75 ± 6.1 d	0.001
PP after	41.5 ± 6.8	40.3 ± 7.3	> 0.05

All values are expressed as mean ± SD

a = mean arterial pressure max based on sample t-test was higher in athletes compared with those of non-athletes; b = mean arterial pressure 6 rest based on sample t-test was higher in athletes compared with those of non-athletes; c = pulse pressure max based on sample t-test was higher in athletes compared with those of non-athletes; d = pulse pressure 6 rest based on sample t-test was higher in athletes compared with those of non-athletes

Conflict of Interests

Authors have no conflict of interests.

References

1. Farpour-Lambert NJ, Aggoun Y, Marchand LM, Martin XE, Herrmann FR, Beghetti M. Physical activity reduces systemic blood pressure and improves early markers of atherosclerosis in pre-pubertal obese children. *J Am Coll Cardiol* 2009; 54(25): 2396-406.
2. Rowell LB. Human cardiovascular control. New York: Oxford University Press; 1993. p. 268.
3. Palatini P. Blood pressure behaviour during physical activity. *Sports Med* 1988; 5(6): 353-74.
4. Fujikawa T, Tochikubo O, Kura N, Umemura S. Factors related to elevated 24-h blood pressure in young adults. *Clin Exp Hypertens* 2009; 31(8): 705-12.
5. Fasting MH, Nilsen TI, Holmen TL, Vik T. Life style related to blood pressure and body weight in adolescence: cross sectional data from the Young-HUNT study, Norway. *BMC Public Health* 2008; 8: 111.
6. Brett SE, Ritter JM, Chowienczyk PJ. Diastolic blood pressure changes during exercise positively correlate with serum cholesterol and insulin resistance. *Circulation* 2000; 101(6): 611-5.
7. Whelton SP, Chin A, Xin X, He J. Effect of aerobic exercise on blood pressure: a meta-analysis of randomized, controlled trials. *Ann Intern Med* 2002; 136(7): 493-503.
8. Howden R, Lightfoot JT, Brown SJ, Swaine IL. The effects of isometric exercise training on resting blood pressure and orthostatic tolerance in humans. *Experimental physiology*. *Experimental Physiology* 2002; 87(4): 507-15.
9. Akis N, Pala K, Meric-Utku A, Seyithan B, Sarandol E, Aytekin H. Hypertension in children (12-14 years)-a case-control study in Bursa, Turkey. *Turk J Pediatr* 2009; 51(5): 437-43.
10. Wright RL, Swain DP, Branch JD. Blood pressure responses to acute static and dynamic exercise in three racial groups. *Med Sci Sports Exerc* 1999; 31(12): 1793-8.
11. Becker MM, Chaves MM, Silva OB, Moreira IE, Victor EG. Arterial blood pressure in adolescents during exercise stress testing. *Arq Bras Cardiol* 2007; 88(3): 329-33.
12. Baba R, Koketsu M, Nagashima M, Inasaka H. Role of exercise in the prevention of obesity and hemodynamic abnormalities in adolescents. *Pediatr Int* 2009; 51(3): 359-63.
13. Tsioufis C, Kyvelou S, Tsiachris D, Tolis P, Hararis G, Koufakis N, et al. Relation between physical activity and blood pressure levels in young Greek adolescents: The Leontio Lyceum Study. *Eur J Public Health* 2011; 21(1): 63-8.
14. Peterson DF, Degenhardt BF, Smith CM. Correlation between prior exercise and present health and fitness status of entering medical students. *J Am Osteopath Assoc* 2003; 103(8): 361-6.
15. Pawloski LR, Davidson MR. Physical activity and body composition analysis of female baccalaureate nursing students. *Nurse Educ Pract* 2003; 3(3): 155-62.
16. Bayat M, Erdem E, Barik O, Baser M, Tasci S. Blood pressure, height, weight and body mass index of primary school students in a low socio-economic district in Turkey. *Int Nurs Rev* 2009; 56(3): 375-80.
17. Angyan L, Teczely T, Karsai I, Petofi A. Comparative analysis of the effects of physical exercise. *Acta Physiol Hung* 2005; 92(1): 19-26.
18. Working meeting on blood pressure measurement: suggestions for measuring blood pressure to use in population surveys. *Rev Panam Salud Publica* 2003; 14(5): 300-5.
19. Veloso J, Polito MD, Riera T, Celes R, Vidal JC, Bottaro M. Effects of rest interval between exercise sets on blood pressure after resistance exercises. *Arq Bras Cardiol* 2010; 94(4): 512-8.
20. Laswar AK, Darwish H. Prevalence of cigarette smoking and khat chewing among Aden university medical students and their relationship to BP and body mass index. *Saudi J Kidney Dis Transpl* 2009; 20(5): 862-6.
21. Owen A, Wiles J, Swaine I. Effect of isometric exercise on resting blood pressure: a meta analysis. *J Hum Hypertens* 2010; 24(12): 796-800.
22. Uusitalo AL, Laitinen T, Vaisanen SB, Lansimies E, Rauramaa R. Physical training and heart rate and blood pressure variability: a 5-yr randomized trial. *Am J Physiol Heart Circ Physiol* 2004; 286(5): H1821-H1826.

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