PRINT: ISSN 0970-9274 ONLINE: 2456-6608
J. Hum. Ecol., 22(3): 215-219 (2007)
DOI: 10.31901/24566608.2007/22.03.06

Relationship Between Cardiorespiratory Fitness, Body Composition and Blood Pressure in Punjabi Collegiate Population

Berry Sadhan, Shyamal Koley and J. S. Sandhu

Department of Sports Medicine and Physiotherapy, Guru Nanak Dev University, Amritsar 143 005, Punjab, India

KEYWORDS Body Composition. Blood Pressure. Cardio Respiratory Fitness.

ABSTRACT The present study deals with the relationship between cardio respiratory fitness, body composition and blood pressure in Punjabi collegiate population (n = 148) aged 19 – 26 years. Height and weight were determined by kinanthropometric methods, blood pressure was measured with subjects lying supine after at least 5 min. rest, VO_2 max was measured by Queen's College Step test. The results indicated that there was a close association with VO_2 max and percent body fat, and systolic blood pressure in boys, but in girls, correlation was found only between VO_2 max and systolic blood pressure.

INTRODUCTION

Aerobic fitness is a very good indicator of cardio respiratory fitness/cardiovascular and exercise tolerance for every day activities which are largely aerobic for the general population (Zuluaga, 1995). Research has indicated the importance of exercise in reducing the risk of cardiovascular diseases, through reduction of blood lipids, body fat, and blood pressure, improvement in myocardial function and as an independent risk factor (Fletcher et al., 1990 and National Heart Foundation, 1991). Thus, the concept of fitness being defined as good condition or good health, tells us that, while we do not expect the general population to compete with athletes, an above average Vo_2 max score indicates a healthy level of cardio respiratory fitness and that an individual is fit to cope with the general demands of living (Zuluaga, 1995). Civilization and industrialization make our life pleasant, jubilant and luxuriant. Indeed, automation and other technologies have contributed greatly to lessening physical activities at work place and home. The assessment of cardio respiratory fitness in children and adolescent has been growing in importance because several data link the VO_2 max with CVD risk factors (Sallis, 1988 and Anderson, 1992). The evidence from longitudinal studies indicate that early identification of cardio vascular risk factors in children, particularly for body fat %, blood lipids, hypertension and cardio respiratory fitness should be addressed as preventive measure in public health perspectives (Kemper, 1989). So these approaches may also be helpful in the studies relating to the young adults.

The studies on relationship among cardio respiratory fitness, body composition and blood pressure in school children are scanty (Guerra et al., 2002). So, the purpose of the present study was to fulfill the lacuna of knowledge in these aspects in young adults especially in Indian context. Therefore, the aim of the present study was to study the relationship between cardio respiratory fitness, body composition and blood pressure in Punjabi collegiate population.

MATERIALS AND METHODS

The sample consisted of 148 randomly selected healthy collegiate boys and girls (99 boys and 49 girls) aged 19-26 years, taken from Guru Nanak Dev University, Amritsar. The mean height and weight of boys and girls were 172.38 cm and 65.87 kg, and 157.92 cm and 53.16 kg, respectively. The consent for voluntary participation was obtained.

Cardio respiratory Fitness: Queen's college step test (McArdle et al., 2001) was used to predict maximal aerobic capacity. It is a standard method to measure one's maximal oxygen uptake using bench stepping sub maximal exercise, suitable for both sexes of adults. Prior to the test, subjects did 5-7 minutes warm up consisting of lower limb muscles stretching and brisk walking. A wooden stepping bench of 16¼ inch. was used along with metronome and stop watch. Metronome was used to monitor the stepping cadence, which was set at 88 beats per minute (22 complete steps per minute) for females and 96 beats per minute (24 complete steps per minute) for males. The step test began after a brief demonstration and practice period. The subjects were asked to perform each stepping cycle to a four-step cadence, up-up-down-down continuously for 3 minutes. After completion of test, subjects remained standing while pulse rate was measured for 15 seconds, 5 to 20 seconds into recovery. Recovery heart rate was converted to beats per minute (15 s HR x 4).

Following equations were used for the estimation of VO_2 max (mL.kg^{-1}min^{-1})

Males: VO_2max = 111.33 – [0.42 x Step-test pulse rate (b.min^{-1})]

Females: VO_2max = 65.81 – [0.1847 x Step-test pulse rate (b.min^{-1})]

Anthropometric Measures and Body Composition: Ten kinanthropometric measurements, viz. height, weight, body mass index, biceps skin fold, triceps skin fold, sub scapular skin fold, upper arm circumference, percent fat, fat mass and fat free mass were taken after Weiner and Lourie (1969).

Blood Pressure: Resting blood pressure was measured using a sphygmomanometer (Mercury Type) and stethoscope. The measurements were taken after subjects were in recumbent position in calm quiet environment for at least 5-7 minutes. Systolic blood pressure and diastolic blood pressure were examined and pooled for each group and gender.

Statistical Analysis: Student t-test was used to compare the 13 variables between boys and girls. Linear regression analysis was used for VO_2 max, fat mass, fat free mass, systolic blood pressure and diastolic blood pressure with other variables in both boys and girls.

RESULTS AND DISCUSSION

Table 1 shows the distribution of mean values and standard deviations of 13 variables in collegiate population of Amritsar. The boys have higher mean values in height (172.38 cm) , weight (65.87 kg) , body mass index (22.16 kg/m^2), upper arm circumference (10.44 cm), fat free mass (58.99 kg), VO_2 max (48.74 ml. kg^{-1} min.$^{-1}$), systolic blood pressure (122.27 mmHg) and diastolic blood pressure (77.51 mmHg) than the girls (157.92 cm, 53.16 kg, 21.30 kg/m^2, 9.26 cm, 43.97 kg, 33.97 ml. kg-1 min.-1, 116.69 mmHg and 73.51 mmHg respectively). Whereas, girls have the higher mean values in biceps skin fold (6.60 mm), triceps skin fold (9.18 mm), sub scapular skin fold (18.33 mm), fat percent (16.73%) and fat mass (9.13 kg) than the boys (3.58 mm, 4.53 mm, 11.58 mm, 10.10% and 6.87 kg respectively). Highly significant differences ($p<0.001$) were noted in height (t=15.73), weight (t=8.02), biceps skin fold (t=8.22), triceps skin fold (t=8.72), sub scapular skin fold (t=6.10), upper arm circumference (t=6.70), %fat (t=9.70), fat mass (t=3.93), fat free mass (t=13.47), Vo_2max (t=12.26), systolic blood pressure (t=4.82) and diastolic blood pressure (t=3.77) among boys and girls. The findings of the present study were supported by Guerra et al. (2002), McArdle et al. (2001), Wilmore et al. (1999), Armstrong and Welsman (1997) and Gerber et al. (1995).

Table 2 shows the linear regression analysis between VO_2 max and other 12 variables in boys

Table 1: Distribution of mean values and standard deviations of 13 variables in collegiate population

S. No.	*Variables*	*Boys (n=99)*	*Girls (n=49)*	*t-value*
		Mean±SD	*Mean±SD*	
1.	Height (cm)	172.38 ±5.08	157.92 ±5.61	15.73***
2.	Weight (kg)	65.87 ±9.19	53.16 ±8.17	8.20 ***
3.	Body Mass Index (kg/m^2)	22.16 ±2.90	21.30 ±3.14	1.64
4.	Biceps skin fold (mm)	3.58 ±1.76	6.60 ±2.68	8.22 ***
5.	Triceps skin fold (mm)	4.53 ±2.89	9.18 ±3.37	8.72***
6.	Sub scapular skin fold (mm)	11.58 ±4.72	18.33 ±8.74	6.10***
7.	Upper arm circumference (inches)	10.44 ±1.02	9.26 ±0.97	6.70***
8.	Fat percent (%)	10.10 ±3.74	16.73 ±4.23	9.70***
9.	Fat Mass (kg)	6.87 ±3.23	9.13 ±3.43	3.93***
10.	Fat Free Mass (kg)	58.99 ±6.82	43.97 ±5.38	13.47***
11.	Vo_2 max (mL.kg^{-1}.min^{-1})	48.74 ±8.25	33.97 ±2.36	12.26***
12.	Systolic Blood Pressure (mmHg)	122.27 ±6.33	116.69 ±7.19	4.82***
13.	Diastolic Blood Pressure (mmHg)	77.51 ±6.09	73.51 ±6.07	3.77***

*** indicates P≤ 0.001

Table 2: Linear regression analysis between VO_2 max and other 12 variables in boys and girls

S. No.	Variables	Boys (n=99)	Girls (n=49)
1.	Height (cm)	0.02	-0.19
2.	Weight (kg)	-0.12	-0.12
3.	Body Mass Index (kg/m^2)	-0.14	-0.04
4.	Biceps skin fold (mm)	-0.21*	-0.19
5.	Triceps skin fold (mm)	-0.27*	-0.12
6.	Sub scapular skin fold (mm)	-0.28*	0.05
7.	Upper arm Circumference (inches)	0.05	-0.01
8.	Fat percent (%)	-0.30***	0.03
9.	Fat Mass (kg)	-0.27*	-0.02
10.	Fat Free Mass (kg)	-0.02	-0.18
11.	Systolic Blood Pressure (mmHg)	-0.23*	-0.31*
12.	Diastolic Blood Pressure (mmHg)	-0.08	0.07

*** indicates $P \leq 0.001$, * indicates $P \leq 0.05$

and girls. The VO_2 max has negatively significant correlations ($p<0.05$) with biceps skin fold (r=0.21), triceps skin fold (r=0.27), sub scapular skin fold (r=0.28), %fat (r=0.30), fat mass (r=0.27) and systolic blood pressure in boys (r=0.23) and in girls (r=0.31). Here, the linear regression analysis showed that, percent fat and fat mass have strong correlations with VO_2 max in boys. The lesser the fat percent and fat mass in boys, greater is the VO_2 max. The study of Guerra et al. (2002) also showed that boys had greater VO_2 max in comparison to girls. This may also be attributed, impart, to boys higher level of hemoglobin concentration and lower level of subcutaneous fat (Armstrong et al., 1997).

The correlation for skin fold measurements (biceps skin fold, triceps skin fold and sub scapular skin fold) with VO_2 max also had been seen in the boys in the present study. This may be attributed to the lower level of fat% in boys, thus producing high VO_2 max values. The systolic blood pressure also had a close correlation with VO_2 max. The boys with lower systolic blood pressure had higher VO_2 max values. This may be due to the fact that there exists certain cardiovascular adaptations with fitness training which cause lower blood pressure. The stroke volume increases with lower heart rate, there by increased capillarization of muscles and greater extraction of oxygen from the arteries. (Wilmore et al., 1999). These results also coincide with our findings.

The linear regression analysis for VO_2 max and various parameters was not found in the girls, may be because the girls selected for the study were purely sedentary without any involvement in physical activity. The results do not match with the study of Guerra et al. (2002) who found correlation between fat%, fat mass and Vo_2max. Only the systolic blood pressure among girls had a correlation with VO_2 max, may be the girls were relaxed and stable. Although there appears to be a genetic component in physical fitness (Malina, 1994), several studies have documented relationship between fitness and cardiovascular disease risk factors in adults and children (Leon, 1981; Armstrong et al., 1992).

The linear regression analysis between fat mass and other 11 variables in boys and girls is given in table 3. The fat mass has positively significant correlations ($p<0.05$) with weight (r=0.81), body mass index (r=0.86), biceps skin fold (r=0.75), triceps skin fold (r=0.82), sub scapular skin fold (r=0.94), upper arm circumference (r=0.67), percent fat (r=0.96) and fat free mass (r=0.61) in boys and with weight (r=0.88), body mass index (r=0.87), biceps skin fold (r=0.78), triceps skin fold (r=0.79), sub scapular skin fold (r=0.90), upper arm

Table 3: Linear regression analysis between fat mass and other 11 variables in boys and girls

S. No.	Variables	Boys (n=99)	Girls (n=49)
1.	Height (cm)	-0.01	0.13
2.	Weight (kg)	0.81*	0.88*
3.	Body Mass Index (kg/m^2)	0.86*	0.87*
4.	Biceps skin fold (mm)	0.75*	0.78*
5.	Triceps skin fold (mm)	0.82*	0.79*
6.	Sub scapular skin fold (mm)	0.94*	0.90*
7.	Upper arm Circumference (inches)	0.67*	0.80*
8.	Fat percent (%)	0.96*	0.95*
9.	Fat free Mass (kg)	0.61*	0.69*
10.	Systolic Blood Pressure (mmHg)	0.04	0.11
11.	Diastolic Blood Pressure (mmHg)	0.07	0.11

*indicates $P \leq 0.05$

Table 4: Linear regression analysis between fat free mass and other 10 variables in boys and girls

S. No.	Variables	Boys (n=99)	Girls (n=49)
1.	Height (cm)	0.47*	0.47*
2.	Weight (kg)	0.96*	0.94*
3.	Body Mass Index (kg/m^2)	0.80*	0.78*
4.	Biceps skin fold (mm)	0.34*	0.52*
5.	Triceps skin fold (mm)	0.33*	0.50*
6.	Sub scapular skin fold (mm)	0.42*	0.49*
7.	Upper arm Circumference (inches)	0.65*	0.82*
8.	Fat percent (%)	0.43*	0.49*
9.	Systolic Blood Pressure (mmHg)	0.17	0.12
10.	Diastolic Blood Pressure (mmHg)	0.14	0.07

* indicates $P \leq 0.05$

circumference (r=0.80), percent fat (r=0.95) and fat free mass (r=0.69) in girls, respectively.

The systolic blood pressure and diastolic blood pressure do not show any correlation with fat mass in both boys and girls. This is in contrary to the result of Gerber et al. (1995) who showed evidence of sex differences in relationship between measures of adiposity and blood pressure.

Table 4 gives the linear regression analysis between fat free mass and other 10 variables in boys and girls. The fat free mass has positively significant correlations ($p<0.05$) with height (r=0.47), weight (r=0.96), body mass index (r=0.80), biceps skin fold (r=0.34), triceps skin fold (r=0.33), sub scapular skin fold (r=0.42), upper arm circumference (r=0.65), and % fat (r=0.43) in boys and with height (r=0.47), weight (r=0.94), body mass index (r=0.78), biceps skin fold (r=0.52), triceps skin fold (r=0.50), sub scapular skin fold (r=0.49), upper arm circumference (r=0.82) and % fat (r=0.49) in girls respectively.

The various skin fold measurements have lower coefficient of regression values in boys depicting greater fat free mass. Lohman (1996) also stated that the density of fat free mass was greater in adult males in comparison to females and children. The coefficient of regression was also having a higher value for fat percent in the girls.

The linear regression analysis between systolic blood pressure and 9 other variables in boys and girls is shown in table 5. The systolic blood pressure has positively significant correlations ($p<0.05$) with diastolic blood pressure in boys (r=0.30) and in girls (r=0.54) respectively. The variation in systolic blood pressure and diastolic blood pressure may be due to interference of other variables like genetics (Malina et al., 1991), socio-economic status (Reddy, 1998) and other metabolic risk factors (Blair et al., 1988). Bachmann et al. (1987) found body mass is the most important determinant of systolic and diastolic blood pressures which is not confirmed by our findings.

Table 5: Linear regression analysis between systolic blood pressure and other 9 variables in boys and girls.

S. No.	*Variables*	*Boys (n=99)*	*Girls (n=49)*
1.	Height (cm)	0.12	0.01
2.	Weight (Kg)	0.14	0.11
3.	Body Mass Index (kg/m^2)	0.09	0.13
4.	Biceps skin fold (mm)	0.04	0.26
5.	Triceps skin fold (mm)	0.08	0.19
6.	Sub scapular skin fold (mm)	-0.01	0.05
7.	Upper arm Circumference (inches)	0.08	0.06
8.	Fat percent (%)	0.00	0.08
9.	Diastolic Blood Pressure (mmHg)	0.30*	0.54*

* indicates $P \leq 0.05$

Table 6 shows the linear regression analysis between diastolic blood pressure and other 8 variables in boys and girls where no significant correlations were noted in any case either in the boys or in the girls. Reddy et al. (1995) have found that body mass index and triceps skin fold thickness were positively correlated with systolic blood pressure and diastolic blood pressure. Balogun et al. (1990) have revealed that strong determinants of blood pressure levels were body mass, body mass index and triceps skin fold thickness but our results do not confirm this.

Table 6: Linear regression analysis between diastolic blood pressure and other 8 variables in boys and girls

S. No.	*Variables*	*Boys (n=99)*	*Girls (n=49)*
1.	Height (cm)	0.09	-0.04
2.	Weight (kg)	0.13	0.09
3.	Body Mass Index (kg/m^2)	0.09	0.12
4.	Biceps skin fold (mm)	-0.04	0.12
5.	Triceps skin fold (mm)	0.11	0.08
6.	Sub scapular skin fold (mm)	0.00	0.11
7.	Upper arm Circumference (inches)	-0.01	0.09
8.	Fat percent (%)	0.03	0.09

Thus from above discussion, it may be concluded that a correlation exists for various variables between cardio respiratory fitness, body composition and blood pressure. In order to have higher fitness profile and to avoid cardiovascular complications, young adults should take care of their food habits and physical activity to maintain a fat free body composition.

REFERENCES

Anderson, G.S.: The 1600 m run and multistage 20 m shuttle run as predictive tests of aerobic capacity in children. *Pediatr Exerc Sci.* **4:** 312-318 (1992).

Armstrong, N. and Welsman J.: *Physical Activity and Aerobic Fitness in Young People*. Oxford Medical Publications, Oxford, pp. 123-36 (1997).

Armstrong, N. Balding J., Gentle P. and Kirby B.: Serum lipids and blood pressure in relation to age and sexual maturity. *Ann. Hum. Biol.,* **19:** 447-487 (1992).

Bachmann, H., Horacek, U., Leowsky, M. and Hirche, H.: Blood pressure in children and adolescents aged 4 to 18. Correlation of blood pressure values with age, sex, body height, body weight and skinfold thickness. *Monatsschr. kinderheilkd*, **135(3):** 128-34 (1987).

Balogun, J.A., Obajuluwa, V.A., Aberreoje, O.K., Olaogun, M.O., Oyeyemi, A.Y. and Balogun, M.O.: Anthropometric determinants of resting blood pressure and heart rate of Nigerian school children. *Ann. Trop. Paediatr,* **10(4):** 425-431 (1990).

Blair, S.N., Ludwig, D.A. and Goodyear, N.N.: A canonical analysis of central and peripheral subcutaneous fat distribution and coronary heart disease risk factors in men and women aged 18-65 years. *Hum. Biol.,* **60:** 111-22 (1988).

Gerber, L.M., Schwartz, J.E., Schnall, P.L. and Pickering, T.G.: Body fat and fat distribution in relation to sex differences in blood pressure. *Am. J. Hum. Biol.*, **7:** 173-182 (1995).

Guerra,S., Ribero, J.C., Costa, R. Duarto, J. and Mota, J.: Relationship between cardiorespiratory fitness, body composition and blood pressure in school children. *J. Sports Med. Phys. Fitness,* **42(2):** 207-213 (2002).

Kemper, H.C.G., Verschuur, R., and de Mey L. Longitudinal change of aerobic fitness in youth ages 12 to 23. *Pediatr. Exerc. Sci.,* **1:** 257-270 (1989).

Leon, A.S., Jacobs, D.R., DeBacker, G. and Taylor, H.L.: Relationship of physical characteristics and life habits to treadmill exercise capacity. *Am. J. Epidemiol.*, **113(6):** 653-660 (1981).

Lohman, T.G.: Applicability of body composition techniques and constants for children and youths. *Exerc. Sports Sci. Rev.*, **14:** 325-357 (1986).

Malina, R.M.: Growth and maturation: normal variation and effect of training. In: Gisolfi CV, Lamb DR, editors. *Perspectives in Exercise Science and Sports Medicine: Youth, Exercise and Sport*. Benchmark Press, Indianpolis, IN, pp. 223-265 (1994).

Malina, R.M. and Bouchard, C.: Genetic regulation of growth, maturation and performance. In: *Growth, Maturation and Physical Activity*. R. M. Malina, C. Bouchard and Bar-Or Ored (Eds.). Human Kinetics Publishers Inc;., Champaign, Illinois, pp. 303-327 (1991).

McArdle, W.D., Katch, I.F. and Katch,L.V.: *Exercise Physiology: Energy, Nutrition and Human Performance*. 5th Ed. Williams and Wilkins, Lippincot (2001).

National Institute of Health, National heart, lung and blood institute: *Clinical Guidelines on the Identification, Evaluation and Treatment of Overweight and Obesity in Adults.* Evidence Report NIH Publication no. 98-4083 (1998).

Reddy, R., V., Udaya Lakshmi, P. and Reddy, N.S.: Blood pressure and anthropometric variation in rural south eastern Andhra Pradesh. *J. Hum. Ecol.*, **6(2):** 126-130 (1995).

Reddy, B.N.: Blood pressure and Adiposty: a comparative study of socio economically diverse groups of Andhra Pradesh, India. *Am. J. Hum. Biol.*, **10:** 5-21 (1998).

Sallis, J.F., Patterson, T.L., Buonom M.J. and Nader, P.R.: Relations of cardiovascular fitness and physical activity to cardiovascular disease risk factors in children and adults. *Am. J. Epidemiol.,* **127:** 933-941 (1988).

Weiner, J.S. and Lourie, J.A.: *Human Biology: A Guide to Field Methods.* Blackwell Scientific Publications, Oxford (1969).

Wilmore, J.H. and Costill, D.L.: *Physiology of Sport and Exercise*, 2nd Ed., Human Kinetics Publishers Inc., Champaign, Illinois (1999).

Zuluaga, M., Briggs, C. and Carsile, J.: *Sports Physiotherapy Applied Science and Practice*. 1st Ed., Churchill Living Stone, London (1995).