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Comparison of Cardiac output of Cricket Players of different Level of Participation before and after Step Test

Lokendra Bahadur Kathayat and Ashok Kumar

Abstract

Aims: The aim of the study was to compare the cardiac output of cricket players of different level of participation before and after step test. **Materials and Methods:** There was one hundred fifty (N=150) trained male cricketers between the ages of 15 and 25 years volunteered for this study. Blood pressure was recorded with a digital sphygmomanometer according to the standardized protocol recommended by World Health Organization. **Results:** The mean age, height weight and BMI (body mass index) of national level cricketer was 17.68±2.21 year, 175.32±7.34 cm, 66.89±8.48 kg and 21.85±3.35 kg/m^2 respectively. The mean age, height weight and BMI (body mass index) of state level cricketer was 17.49±2.79 year, 169.85±7.18 cm, 55.10±8.46 kg and 19.03±2.14 kg/m^2 respectively. The mean age, height weight and BMI (body mass index) of district level cricketer was 17.94±2.78 year, 171.22±7.04 cm, 56.28±9.49 kg and 19.14±2.77 kg/m^2 respectively. The mean age, height weight and BMI (body mass index) of university level cricketer was 24.50±0.57 year, 179.00±4.24 cm, 68.75±7.45 kg and 21.41±1.41 kg/m^2 respectively. The mean age, height weight and BMI (body mass index) of school cricketer was 17.38±2.01 year, 170.06±7.67 cm, 55.69±7.98 kg and 19.21±2.03 kg/m^2 respectively. The mean cardiac output (resting) of national level, state level, district level, university level and school level cricket players was 5.94±1.25 (L/min), 6.06±1.20 (L/min), 6.29±0.97 (L/min), 5.70±0.83 (L/min) and 6.37±1.06 (L/min) respectively. The mean cardiac output (after Queen's step test) of national level, state level, district level, university level and school level cricket players was 11.47±2.06 (L/min), 10.74±2.24 (L/min), 10.55±1.61 (L/min), 8.33±0.88 (L/min) and 11.56±1.85 (L/min) respectively. **Conclusion:** It was concluded that the cardiac output was statistical significantly increased after step test than at rest of cricket players of different level of participation. There was a statistical significant difference in the variance of mean cardiac output (after Queen's step test) of national level, state level, district level, university level and school level cricket players.

Lokendra Bahadur Kathayat
Assistant Professor
Department of Physical Education
RIMT University Mandi Gobindgargh, Punjab, India.
Email: lukskathayat@gmail.com
Ashok Kumar
Professor
Department of Sports Science
Punjabi University (Patiala) Punjab, India.
Email: akashokin@gmail.com

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Introduction

Nowadays cricketers endure extreme training to be in highest state of physical fitness. Cardiac output (CO) is the quantity of blood or volume of blood that is pumped by the heart per minute. Cardiac output is a function of heart rate and stroke volume (Hussien et al. 2011). It is the product of stroke volume (SV; the volume of blood ejected from the heart in a single beat) and heart rate

(HR; expressed as beats per minute) (Zhuang et al. 2011). Increasing either heart rate or stroke volume increases cardiac output. Most of the strokes are caused by atrial fibrillation (Duning et al. 2011). Cardiac Output in ml/min = heart rate (beats/min) X stroke volume (ml/beat). An average person has a resting heart rate of 70 beats / minute and a resting stroke volume of 70 ml/beat. The cardiac output for this person at rest is: Cardiac Output = 70 (beats/min) X 70 (ml/beat) = 4900 ml/ minute. The total volume of blood in the circulatory system of an average person is about 5 liters (5000 ml).With strenuous activity, an adult's cardiac output can increase up to 7 fold (35 liters/minute) to satisfy the body's demand for oxygen and nutrients. Treatment for multiple congenital cardiac defects usually refers to open-heart surgery or a combination of medical treatment and open heart surgery (Kula et al. 2011) and Leurent et al., (2010). The timing and outcomes of cardiovascular disease are linked with surrounding power fields also (Mikirova et al. 2011). Exercise and maximum cardiac output, in healthy young individuals, HR may increase to 150 bpm during exercise. The stroke volume (SV) can also increase from 70 to approximately 130 mL due to increased strength of contraction. This would increase CO to approximately 19.5 L/min, 4–5 times the resting rate. Top cardiovascular athletes can achieve even higher levels. At their peak performance, they may increase resting CO by 7–8 times. Since the heart is a muscle, exercising it increases its efficiency. The difference between maximum and resting CO is known as the cardiac reserve. It measures the residual capacity of the heart to pump blood (Cardiac Physiology, 2013).Maximal heart rate (HR) varies innately among individuals and decreases with age. The increase in heart rate (HR) is responsible for the majority of the augmentation of Cardiac output (CO) during exercise, and peak HR heart rate (HR) is a fundamentally limiting factor of peak exercise capacity in healthy individuals. However, maximal heart rate (HR) does not increase with exercise training; thus, it is not considered to be an adaptable property. In contrast, stroke volume (SV) both at rest and during exercise increases with prolonged exercise training (Baggish 2013). Stroke volume (SV) rises during exercise due to increases in ventricular end-diastolic volume and, to a lesser degree, due to sympathetically mediated reductions in end-systolic volume (Rowell 1986). Cardiac output will continue to increase till the point where a plateau is reached (Adikali et al. 2017). There are very few studies that have been conducted on male cricket players of Punjab to observe their physiological status of haemodynamic variables. The present study was conducted on male cricket players to observe their cardiac output before and after step test according to their level of participation in Patiala, Punjab.

Materials and Methods

One hundred fifty (N=150) Punjabi male cricketers of different cricket academies located in Patiala (Punjab) between the age group of 15 to 25 years voluntarily participated in the present study. Anthropometric measurements were recorded according to the standard procedure. Blood pressure was recorded with a digital sphygmomanometer according to the standardized protocol recommended by World Health Organization. Blood pressure was measured at rest and after the completion of queens step test. The blood pressure in the arteries rises and falls with the phases of the heart beat. The highest pressure in the arteries, produced as a result of ventricular contraction is known as the systolic blood pressure. The lowest pressure in the arteries, produced as a result of ventricular relaxation is known as the diastolic blood pressure. The cardiac output was calculated with the help of the standard equations given by Jackson et al., (1955). Cardiac Output (ml/min) = Heart Rate (beats/min) × Stroke Volume (ml/beat)

Results

The mean age, height weight and BMI (body mass index) of national level cricketer was 17.68±2.21 year, 175.32±7.34 cm, 66.89±8.48 kg and 21.85±3.35 kg/m^2 respectively (Table1). The mean age, height weight and BMI (body mass index) of state level cricketer was 17.49±2.79 year, 169.85±7.18 cm, 55.10±8.46 kg and 19.03±2.14 kg/m^2 respectively (Table1).The mean age, height weight and BMI (body mass index) of district level cricketer was 17.94±2.78 year, 171.22±7.04 cm, 56.28±9.49 kg and 19.14±2.77 kg/m^2 respectively (Table1). The mean age, height weight and BMI (body mass index) of university level cricketer was 24.50±0.57 year, 179.00±4.24 cm, 68.75±7.45 kg and 21.41±1.41 kg/m^2 respectively (Table1). The mean age, height weight and BMI (body mass index) of school cricketer was 17.38±2.01 year, 170.06±7.67 cm, 55.69±7.98 kg and 19.21±2.03 kg/m^2 respectively (Table1).

Table 1. Mean ±SD of Age, height weight and BMI of Cricket Players

Level of Participation	N	Age, (year)	Height (cm)	Body weight (kg)	BMI (kg/m^2)
National	**19**	**17.68±2.21**	**175.32±7.34**	**66.89±8.48**	**21.85±3.35**
State	**39**	**17.49±2.79**	**169.85±7.18**	**55.10±8.46**	**19.03±2.14**
District	**36**	**17.94±2.78**	**171.22±7.04**	**56.28±9.49**	**19.14±2.77**
University	**4**	**24.50±0.57**	**179.00±4.24**	**68.75±7.45**	**21.41±1.41**
School	**52**	**17.38±2.01**	**170.06±7.67**	**55.69±7.98**	**19.21±2.03**
Total	**150**	**17.77±2.66**	**171.19±7.52**	**57.45±9.42**	**19.54±2.58**

The mean cardiac output (resting) of national level, state level, district level, university level and school level cricket players was 5.94±1.25 (L/min), 6.06±1.20 (L/min), 6.29±0.97 (L/min), 5.70±0.83 (L/min) and 6.37±1.06 (L/min) respectively (Table 2). The maximum mean cardiac output at rest was 6.37±1.06 L/min of school level. The minimum cardiac output at rest was 5.70±0.83 L/min of university level (Table 2). The mean cardiac output (after Queen's step test) of national level, state level, district level, university level and school level cricket players was 11.47±2.06 (L/min), 10.74±2.24 (L/min), 10.55±1.61 (L/min), 8.33±0.88 (L/min) and 11.56±1.85 (L/min) respectively (Table 2). The maximum mean cardiac output after Queen's step test was 11.56±1.85 L/min of school level. The minimum cardiac output after Queen's step test was 8.33±0.88 L/min of university level (Table 2). The mean difference in the cardiac output (5.52 L/min) at rest and after queen's step test of national was statistical significant, in other words we can say that there was significantly an increased in cardiac output after queen's step test of national level (Table 2). The mean difference in the cardiac output (4.68 L/min) at rest and after queen's step test of state level was statistical significant, in other words we can say that there was an increased in cardiac output after queen's step test of state level (Table 2). The mean difference in the cardiac output (4.26 L/min) at rest and after queen's step test of district level was statistical significant, in other words we can say that there was an increased in cardiac output after queen's step test of district level (Table 2). The mean difference in the cardiac output (2.63 L/min) at rest and after queen's step test of university level was statistical significant, in other words we can say that there was an increased in cardiac output after queen's step test of university level (Table 2). The mean difference in the cardiac output (5.18 L/min) at rest and after queen's step test of school was statistical significant, in other words we can say that there was an increased in cardiac output after queen's step test of school level (Table 2).

Table 2. Comparison of Cardiac output (resting) of Cricket Players

Level of Participation		Cardiac Output (L/min, at rest)		Cardiac Output (L/min, after Queen's step test)		Mean difference	t	Sig. (2-tailed)
	N	Mean	Std. Deviation	Mean	Std. Deviation			
National	19	5.94	1.25	11.47	2.06	5.52	-10.01	0.00
State	39	6.06	1.20	10.74	2.24	4.68	-11.74	0.00
District	36	6.29	0.97	10.55	1.61	4.26	-12.15	0.00
University	4	5.70	0.83	8.33	0.88	2.63	-3.67	0.03
School	52	6.37	1.06	11.56	1.85	5.18	-18.86	0.00
Total	150	6.20	1.10	11.01	2.00	4.81	-26.20	0.00

The variance in the mean cardiac output (resting) of cricket players on the basis of their different level of participation was statistical analyzed with the help of ANOVA. The results of ANOVA showed that there was no statistical significant difference in the variance of mean cardiac output (resting) of national level, state level, district level, university level and school level cricket players (Table 3).

Table 3. Analysis of Variance (ANOVA) of Cardiac output (resting) of Cricket Players

Variable(s)		Sum of Squares	df	Mean Square	F	Sig.
Cardiac output (L/min) (resting)	Between Groups	4.82	4	1.20	0.98	0.41
	Within Groups	177.45	145	1.22		
	Total	182.27	149			

The variance in the mean cardiac output (after Queen's step test) of cricket players on the basis of their different level of participation was statistical analyzed with the help of ANOVA. The results of ANOVA showed that there was a statistical significant difference ($F = 3.91$ $p<0.01$) in the variance of mean cardiac output (after Queen's step test) of national level, state level, district level, university level and school level cricket players (Table 4).

Table 4. Analysis of Variance (ANOVA) of Cardiac output (after queen's step test) of Cricket Players

Variable(s)		Sum of Squares	df	Mean Square	F	Sig.
Cardiac output (L/min) (after Queen's step test)	Between Groups	58.18	4	14.54	3.91	0.00
	Within Groups	538.54	145	3.71		
	Total	596.73	149			

Further, the results of scheffe posthoc showed that there was a statistical significant difference in cardiac output (after Queen's step test) university level vs. school level cricket players (Table 5).

Table 5. Posthoc (Scheffe) Multiple Comparisons of Cardiac output (after queen's step test) of Cricket Players

Dependent Variable	I) level of participation	(J) level of participation	Mean Difference (I-J)	Sig.
Cardiac Output (after Queen's step test)	**National**	**State**	**726.58**	**0.76**
		District	**918.86**	**0.58**
		University	**3135.65**	**0.07**
		School	**-85.46**	**0.99**
	State	**District**	**192.28**	**0.99**
		University	**2409.07**	**0.23**
		School	**-812.04**	**0.41**
	District	**University**	**2216.79**	**0.31**
		School	**-1004.32**	**0.22**
	University	**School**	**-3221.11***	**0.03**

Discussion

The results of the present study shows that cardiac output (at rest) of the cricket players were in the normal range (4.0-8.0 L/min) as per the norms recommended by Edwards's Life Sciences (Edwards, 2009). Rowell (1986) reported that the pattern of blood flow changes dramatically when a person goes from resting to exercising. At rest, the skin and skeletal muscles receive about 20 percent of the cardiac output. The cardiac output increases as the rate of oxygen demand increases. However, this linear relationship has a certain limit after which the cardiac output stays constant. When a person is at rest, only 20% of the cardiac output goes to the skin and the skeletal muscles. However, when a person is exercising, more blood needs to flow toward the highly metabolic skeletal muscles. This is to allow the provision of more oxygen and removal of waste products such as carbon dioxide from the skeletal muscles. It is estimated that up to 80% of the cardiac output is supplied to the skeletal muscles during exercise (Lecturio 2016).However, at the maximal level of exercise, the cardiac output increases by up to 30%. After training, stroke volume is increased at rest, during sub-maximal and at maximal training. The heart rate, on the other hand, is decreased at rest and sub-maximal training. It may remain unchanged during maximal training. The increase in stroke volume in endurance training is due to an increase in the blood volume**.** This is due to increases in the venous return, thus to an increase in end-diastolic volume**.** In addition, hypertrophy of the cardiac muscles also occurs, which increases the overall force of contraction (Lecturio 2016).

Conclusion

It was concluded that the cardiac output was statistical significantly increased after step test than at rest of cricket players of different level of participation. There was a statistical significant

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difference in the variance of mean cardiac output (after Queen's step test) of national level, state level, district level, university level and school level cricket players.

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