

Original Article

Effect of pre-cooling and warm-up on aerobic endurance performance

S.T.N. RAJESWARAN,¹ G. SHIVAJI², G.JEYAVELMURUGAN³

¹Reader, Department of Physical Education, Bharathiar University, Coimbatore, INDIA.

^{2,3}Phd, Research Scholars, Department of Physical Education, Bharathiar University, Coimbatore, INDIA.

Published online: December 25, 2011

(Accepted for publication December 18, 2011)

Abstract

The purpose of this study was to find out the effects of pre-cooling and a warm-up programme on endurance performance. Twelve male students from Dr.Sivanthi Aditanar College of Physical Education, Thiruchendur were participant randomly sampled. The age of the participant was ranged from 21 to 25 years. The selected variables of heart rate and endurance performance were assessed by using treadmill test. For the first ten minutes treadmill speed was fixed at 9.5km. Then every five minutes the speed will be increased to 1km/h. At the same time heart rate was noted. In addition to that the participant were unable to run on a particular speed, time and distance were noted. The obtained data were statistically analysed with 2x5 single factor repeated measure ANOVA was used to find out the significant difference, Newman-keuls test was used as a post-hoc test. An alpha level of 0.05 was used for all tests. The results indicate that a pre-cooling programme increased exercise endurance performance.

Keywords: pre-cooling, warm-up and endurance.

Introduction

The concept of pre-cooling is not new, research evidence to date is inconclusive for its effectiveness in improving team-sport exercise performance (Duffield et al. 2003). It is true that research has tended to focus on how body cooling can aid the performance of endurance athletes competing in hot, humid environments. But there is growing evidence that pre-cooling can offer performance advantages in a range of temperatures, during training as well as competition, and in non-continuous sports. Exercise causes the body temperature to rise, and the harder body work the more rapid this rise will be. This rise in core temperature (T_c) can be modified by increased fitness but is exacerbated in hot and humid conditions. However, regardless of training state or climate, it is apparent that there is a critical limiting T_c, at which point athletes are forced to either reduce exercise intensity or risk heat-related illness. Because the amount of heat stored in the body will limit the duration of exercise at a given intensity, it obviously makes sense to start exercising with as cool a body temperature as possible – ie by pre-cooling. In essence, the purpose of body cooling techniques is to increase the margin between your starting T_c and the T_c that will force a reduction in pace. The implementation of pre-cooling is a decision for the coach and/or sports scientist as to whether the benefits outweigh the costs for effective pre-cooling; however, understanding player game demands may lead to effective individualized pre-cooling strategies for selected players.

Methods:

Twelve male students from Dr.Sivanthi Aditanar College of Physical Education, Thiruchendur were selected as participant randomly. The age of the participant was ranged from 21 to 25 years. The selected variables of heart rate and endurance performance were assessed by using treadmill test.

Pre-cooling procedure: Twelve men participants between 21 to 25 years of age performed two endurance tests over a period of one week. Both tests were performed in the physiology laboratory in Dr.Sivanthi Aditanar College of Physical Education, Thiruchendur, in an ambient temperature of 32⁰c. All the participants were advised to take bath and followed by 20 minutes icing, which included icing in the arm, thigh, calf, chest, abdomen muscles and back side of the body. Finally participants were asked to run on the treadmill.

Warm-up procedure: All the participants were advised to do the 20 minutes warm-up exercises which included running, jogging and stretching of the muscles. Finally participants were asked to run on the treadmill.

Statistical Technique:

The obtained data were statistically analysed with 2x5 single factor repeated measure ANOVA was used to find out the significant difference, Newman-keuls test was used as a post-hoc test. In all the cases the criterion for statistical significance was fixed at 0.05 level of confidence (P<0.05).

Results:

Table - I
Mean and standard deviation of pre-cooling and warm-up programme on heart rate and endurance performance

Variables		Pre-cooling programme	Warm-up programme
		Mean $\pm$ SD	Mean $\pm$ SD
Heart rate	5min	135.67 $\pm$ 28.57	153.83 $\pm$ 16.84
	10 min	154.50 $\pm$ 18.47	156.67 $\pm$ 16.21
	15 min	165.33 $\pm$ 11.49	164.92 $\pm$ 11.39
	20 min	166.92 $\pm$ 14.71	168.33 $\pm$ 7.73
	25 min	170.75 $\pm$ 14.57	164.17 $\pm$ 15.38
Endurance Performance		5.81 $\pm$ 1.34	5.33 $\pm$ 0.92

Table -I reveals that obtained mean value on pre-cooling programme of heart rate in 5min was 135.67, standard deviation of 28.57, 10min was 154.5, standard deviation of 18.47, 15min was 165.33, standard deviation of 11.49, 20min was 166.92, standard deviation of 14.70, 25min was 170.75, standard deviation of 14.57 and endurance performance was 5.81, standard deviation of 1.34.

The mean value on warm-up programme of heart rate in 5min was 153.83, standard deviation of 16.84, 10min was 156.67, standard deviation of 16.21, 15min was 164.92, standard deviation of 11.39, 20min was 168.33, standard deviation of 7.73, 25min was 164.17, standard deviation of 15.38 and endurance performance was 5.33, standard deviation of 0.92.

Table - II
Repeated measures for the data on heart rate of pre-cooling and warm-up programme

Source of variance	SS	df	MS	F
A(warm-up, Pre-cooling)	261.07	2	130.53	0.48
B (Various Time)	9409.06	4	2352.26	8.74*
A x B (warm-up x Pre-cooling)	2020.34	4	505.08	1.88
Within treatment	29593.11	110	269.30	
Total	41283.59	120		

*significant at 0.05 level (4,110) = 2.46.

Table - II shows that the f value between pre-cooling and warm-up was 0.48 and the f value of interaction of pre-cooling and warm-up was 1.88. the obtained f-value is less than the table value of 2.46 with df 4 and 110 required for significance at 0.05 level. The obtained f-value of various time duration was 8.74. Since the f-value is greater than the table value, it indicates that there was a significant difference among the various time duration on the heart rate.

Table - III
Newman - keuls test for difference of the various time means of heart rate of pre-cooling programme.

Times / Mean	5min	10 min	15 min	20 min	25 min	C.I
5min	135.67	154.50	165.33	166.92	170.73	
10min	---	18.83*	29.66*	31.25*	18.49*	18.49
15min	---	---	10.83	12.42	17.41	17.41
20min	---	---	---	1.59	15.85	15.85
25min	---	---	---	---	3.83	13.20

*significant at 0.05level

Table -III shows that the mean difference in heart rate between 5min and 10 min, 5 min and 15min, 5min and 20 min and 5min and 25 min are 18.83,29.66,31.25 and18.49 respectively, which are higher than the critical value of 18.49 at 0.05 level. The results of the study indicates that there was a insignificant difference between 10min and 15min, 10min and 20min, 10min and 25min, 15min and 20min, 15min and 25min and 20min and 25min on heart rate.

Table - IV
Newman - keuls test for difference of the various time means of heart rate of warm-up programme.

Times / Mean	5min	10 min	15 min	20 min	25 min	C.I
5min	153.83	156.67	164.92	168.92	164.17	
10min	---	2.84	11.09	15.09	10.34	18.49
15min	---	---	8.25	1.25	7.5	17.41
20min	---	---	---	4.00	0.75	15.85
25min	---	---	---	---	4.75	13.20

*significant at 0.05level

Table - IV indicates that there was insignificant difference among the various times on heart rate at 0.05 level of confidence.

Table - V
Repeated measures for the data on endurance performance of pre-cooling and warm-up programme

Source of variance	SS	df	MS	F
Between	24.38	11		
Within	6.17	12		
Treatment	739.541	1	739.541	1719.86*
Residual	4.772	11	0.43	
Total	774.26	35		

*Significant at 0.05 level. (1, 11) = 4.84.

Table - V showed that the F-ratio value treatment with pre-cooling and warm-up programme was 1719.86. The obtained F-ratio value is greater the table value of 4.84 with df 1 and 11 required for significance at 0.05 level. It indicates that there was a significant difference between pre-cooling and warm-up programme on endurance performance.

Discussion and Findings

Heart rate

There was no significant difference between pre-cooling and warm-up programme on heart rate. In considering the interaction of pre-cooling and warm-up programme that there was no significant difference on heart rate. There was insignificant difference among the various time duration (5min, 10min, 15min, 20min and 25min) of warm-up programme on heart rate. Due to the effect of pre-cooling programme heart rate was increased slowly when compared to the warm-up programme. Pre-cooling was effective in reducing thermal strain, thereby enabling the participant to increase exercise intensity towards the end of the trail. There was a significant difference among the various time duration (5min, 10min, 15min, 20min and 25min) of pre-cooling programme on heart rate. The above findings of the present study are in agreement with the studies conducted by Uckert and Joch, 2007 and Webster et.al., 2000.

Endurance performance

There was a significant difference between pre-cooling and warm-up programme on endurance performance. For enhancing the endurance performance pre-cooling programme is substitute for the warm-up programme in hot climates. The above findings of the present study are in agreement with the studies conducted by Uckert and Joch, 2007, Booth et.al., 1997, Cooter, et.al., 2001, Sleivert et.al., 2001, Dannen et.al and Webster et.al., 2000.

Conclusions:

On the basis of the finding of the study, the following conclusions were drawn.

1. 20 minutes of pre-cooling and warm-up programme did not influence the significant changes in heart rate.
2. Due to the effect of pre-cooling programme heart rate was increased slowly when compared to the warm-up programme.
3. In considering the interaction of pre-cooling and warm-up programme that there was no significant difference on heart rate.
4. There was significant difference among the various time duration (5min and 10 min, 5 min and 15min, 5min and 20 min and 5min and 25 min) of pre-cooling programme on heart rate.
5. There was insignificant difference among the various time duration (5min, 10min, 15min, 20min and 25min) of warm-up programme on heart rate.
6. There was a significant difference between pre-cooling and warm-up programme on endurance performance.
7. Enhancing the endurance performance pre-cooling programme is substitute for the warm-up programme in hot climates.

References:

- Duffield R, Dawson B, Bishop D, Fitzsimons M and Lawrence S (2003) Effect of wearing and ice cooling jacket on repeat sprint performance in warm/humid conditions. Br J Sports Med 37: 164- 169.
- Booth J., et.al., (2004), "Cooling vest worn during active arm-up improves 5 km run performance in the heat", journal application of physiology, 9:5, PP. 1867-74.

- Cooter J.D., et al., (2001), "Effect of pre-cooling, with and without thigh cooling, on strain and endurance exercise performance in the heat", *Journal of Sports Sciences*, 22:7, PP.605-12.
- Dannen H.A., et.al., (2006), "Heart strain and gross efficiency during endurance exercise after lower, upper or whole body pre cooling in the heat", *International journal of sports Medicine*, 27:5, PP.379-88
- Uckert S. and Joch W., (2007), "Effects of warm-up and pre-cooling on endurance performance in the heat", *IAAF New Studies in Athletics*, 41:6, PP.380-4.
- Webster J. et.al., (2000), "A light weight cooling vest enhances performance of athletes in the heat", *International journal of sports Medicine*, 10,48:7, PP.821-37.

JPES