Recent Research in Science and Technology 2010, 2(3): 98-103
ISSN: 2076-5061
www.recent-science.com

PHYSICAL EDUCATION AND SPORTS SCIENCES

EFFECTS OF PRECOOLING ON THERMOREGULATION AND PERFORMANCE OF LONG DISTANCE RUNNERS IN HOT HUMID CLIMATE

Sajeev Jos[1], Tony Daniel[2], George Abraham[3*], Cicily Pearly Alex[4]

[1]*Lecturer, Department of Physical Education, St. Mary's B. Ed College, Kottayam, India*
[2]*Director, Venue Operations, Commonwealth Games 2010, New Delhi, India*
[3]*Assistant Professor, Department of Physical Education and Sports Sciences, Annamalai University, India*
[4]*Director, Department of Physical Education, St. Xavier's College for Women, Aluva, India*

Abstract

The purpose of the study was to analyze the effects of pre-cooling on thermo regulation and performance of long distance runners in army sports institute. Eight long distance runners of Pune Army Sports institute were selected as subjects. The subjects were selected at random, they were divided in two equal groups for each, and each group will undergo experimental conditions using cooling strategy, during warm up before treadmill test and one control condition with out cooling jacket. The cooling strategy was applied by using cooling jacket for 10 minutes before warm up and during 20 minutes warm up continued by the tread mill test running to exhaustion. The data of criterion variables like core temperature (Tc), Heart Rate (HR), Respiratory Rate (RR) and Blood lactate level (BL) was collected from each subjects before and after each test conditions .The collected data was statistically analyzed by using analysis of variance (ANOVA) with repeated measures and Tukey's post hoc test were applied to determine the significant differences between the mean. Correlation were also made using Pearson's Product moment correlation statistics on (1) Core body temperature & environment (2) Total distance run by athletes in control & Experimental condition(3) Total time run by athletes in control and experimental condition .The results of the study showed that there was significant difference in the mean of total time run by the athletes in thread mill before reaching the Exhaustion Level among the experimental condition and controlled condition.

Keywords: Precooling,Thermoregulation, Hot humid climate, Long distance runners.

Introduction

Exercise physiology is an aspect of sports medicine that involves the study of how the body from a functional stands point, response, adjust and adapts to exercise. Various experiment conducted in recent years have conclusively proved that the performance in any sports activity depends upon the psycho physiological hemeostasis and physical fitness as well as related skills of athletes. (Atkinson, 1993)

Maximum Day temperature, in the Tropics generally averages more than 30°C all the year round. In the wet season, humidity is also high. Hot and humid conditions limit cooling, because the temperature and vapour gradients between the skin and air are not contusive to loss of heat in such conditions, body temperature becomes a factor limiting performance of high intensity endurance exercise (Morris et al, 1998). Strategies that reduce resting body temperature or enhanced dissipation of heat can there for enhanced performance. Application of ice via and Ice jacket can be done for pre cooling before an event.

Methodology

To achieve this purpose of the study, eight long distance runners of Army sport institute – Pune, aged between 18- 30 years were selected as subjects. They were national, state and university level athletes. Eight subjects were divided in to two groups of four athletes each. The first group was to undergo experimental condition1 and control condition. The second group will undergo control condition and then the experimental condition. In the experimental condition test, there will be four phase-Phase1-normal, PhaseII- 10 minutes with cooling jacket, Phase III- 20 minute warm up with cooling jacket and Phase IV – Tread mill test running to exhaustion with out cooling jacket. In the treadmill test, the subjects were asked to run the initial 10 minute in 9 Km/minute speed. After 10 minutes, the speed will be increased at the rate of 1 km/minute after every 1 minute of run the athlete reach the exhaustion level .All the subjects were tested on selected criterion variables prior to and immediately after each phase of the test .The time taken to reach the exhaustion level were measured

* Corresponding Author, *Email*: iadoreambattu@yahoo.co.in

during the experimental condition and control condition.

Analysis of the data and the results of the study

The collected data on selected criterion variables have been analyzed and the results are presented below.

Karl Pearson's Product Moment Correlation was used to find out whether there was any significant increase in the core body temperature of 12 subjects in relation with the increase in the environmental heat index.

The Core temperature (Tc) of 12 subjects that we got during the pilot study test conducted on 7th of July 2007 was correlated with the core temperature got during the original test conducted on 24th of October. This have been statistically analyzed and presented in Table I.

Table I

		JULY	OCTOBER
JULY 7th	Pearson Correlation	1	.988**
	Sig. (2-tailed)	.	.000
	N	12	12
OCT 24th	Pearson Correlation	.988**	1
	Sig. (2-tailed)	.000	.000
	N	12	12

**Correlation is significant at the 0.05 level

Correlation Coefficient between the core temperature during July 7 and October 24 is 0.988**. The correlation is highly significant at .05 level of confidence.

According to the statistical analysis, based on the ANOVA table there was a significant reduction, in core temperature (Tc) at .05 level, when we compared the (Tc) of Cooling jacket conditions (Experimental condition I and Experimental condition II) with the Tc of non jacket condition (Control condition) during the 10 minute stage, 20 minute warm up stage and in the Canadian fit test stage. Since there was a significant difference in Core Temperature, the Tukey's post Hoc test was applied as a follow-up test.

Post Hoc Tests

Tukey HSD

Multiple Comparisons Table II

Dependent Variable	(C) GROUP	(E) GROUP	Mean Difference (C-E)	Std. Error	Sig.
10 Min.	1	2	1.192*	.3110	.002
		3	.992*	.3110	.009
	2	1	-1.192*	.3110	.002
		3	-.200	.3110	.798
	3	1	-.992*	.3110	.009
		2	.200	.3110	.798
10 Min. warm-up	1	2	1.050*	.3178	.006
		3	1.525*	.3178	.000
	2	1	-1.050*	.3178	.006
		3	.475	.3178	.306
	3	1	-1.525*	.3178	.000
		2	-.475	.3178	.306
Canadian Test	1	2	.742*	.1923	.001
		3	1.458*	.1923	.000
	2	1	-.742*	.1923	.001
		3	717*	.1923	.002
	3	1	-1.458*	.1923	.000
		2	-.717*	.1923	.002

*. The mean difference is significant at the .05 level. C- Control GroupE- Experimental Group

The Tukey's post Hoc test for the differences between paired means of Control condition with Experimental condition I and Experimental condition II.

The above table clearly indicates that the mean difference of core temperature (Tc) between the Control conditions and Experimental condition-I ,Control condition and Experimental condition II during 10 minute stage where 1.192* ,0.992* respectively which shows that there is significant difference at 0.05 level of confidence. The mean difference of core temperature between Control condition with Experimental condition I, Control condition with Experimental condition II, during 20 minute warm-up stages were 1.050*, 1.525* respectively which shows that there is significant difference at 0.05 level of confidence. The mean difference of core temperature between Control condition with Experimental condition I, Control condition with Experimental condition II and Experimental condition I with Experimental condition II during Canadian Fit test stages were 0.742*, 1.458*, 0.717* respectively which shows that there is significant difference at 0.05 level of confidence.

According to the statistical analysis, based on the ANOVA table there was a significant reduction, in Heart Rate (HR) at 0.05 level, when we compare the (HR) of Cooling jacket conditions (Experimental condition I and Experimental condition II) with the (HR) of non-jacket (controlled condition) during the Canadian fit test stage. Since there was a significant difference in heart rate, the Tukey's post Hoc test was applied as a follow-up test.

Post Hoc Tests

Multiple Comparisons

Tukey HSD

Table III

Dependent Variable	(C) GROUP	(C) GROUP	Mean Difference (I-J)	Std. Error	Sig.
Canadian Test	1	2	6.42*	2.571	.046
		3	10.50*	2.571	.001
	2	1	-6.42*	2.571	.046
		3	4.08	2.571	.265
	3	1	-10.50*	2.571	.001
		2	-4.08	2.571	.265

* The mean difference is significant at the .05 level.

The Tukey's post Hoc test for the differences between paired mean of controlled condition I with experimental condition II.

The above table clearly indicates that the mean difference of Heart Rate (HR) between the Controlled conditions and Experimental condition I, Controlled condition and Experimental condition II during Canadian Fit test stages were 6.42* ,10.50* respectively which shows that there is significant difference at 0.05 level of confidence..

According to the statistical analysis, based on the ANOVA table there was a significant reduction in Blood Lactate Level (BL) at .05 level, when we compared the (BL) of Cooling jacket conditions (Experimental condition I and Experimental condition II) with the (BL) of non-jacket condition (Control condition) during the 10 minute stage, 20 minute warm-up stage and in the Canadian Fit Test stage.

The Tukey's post Hoc test for the differences between paired mean of Controlled condition with Experimental condition I and Experimental condition II.

The above table clearly indicates that the mean difference of Blood Lactate Level (BL) between the Controlled condition and Experimental condition - II was 0.192* which shows that there is significant difference at 0.05 level of confidence. The mean difference of (BL) between Control condition with Experimental condition I, Control condition with Experimental condition II, during 20 minute warm up stages were 0.59*,0.77* respectively which shows that there is significant difference at 0.05 level of confidence. The mean difference of (BL) between Control condition with Experimental condition I, Control condition with Experimental condition II during Canadian Fit test stages were 2.483*, 3.158* respectively which shows that there is significant difference at 0.05 level of confidence.

The distance run by 12 subjects during the Control condition, Experimental condition I and Experimental condition II were correlated with each other. This has been statistically analyzed and the result is presented in Table- V.

Post Hoc Tests

Multiple Comparisons

Table IV

Tukey HSD

Dependent Variable	(C) GROUP	(E) GROUP	Mean Difference (C-E)	Std. Error	Sig.
10 Min.	1	2	.058	.0699	.685
		3	.192*	.0699	.026
	2	1	-.058	.0699	.685
		3	.133	.0699	.153
	3	1	-.192*	.0699	.026
		2	-.133	.0699	.153
10 Min. warm-up	1	2	.59*	.095	.000
		3	.77*	.095	.000
	2	1	-.59*	.095	.000
		3	.18	.095	.145
	3	1	-.77*	.095	.000
		2	-.18*	.095	.145
Canadian Test	1	2	2.483*	.3597	.000
		3	3.158*	.3597	.000
	2	1	-2.483*	.3597	.000
		3	.675	.3597	.161
	3	1	-3.158*	.3597	.000
		2	-.675	.3597	.161

*. The mean difference is significant at the .05 level.
C- Control Group, E- Experimental Group

Correlations

Table- V

		CONTROL	Exp-I	Exp-II
CONTROL	Pearson Correlation	1	.994**	.994**
	Sig. (2-tailed)	.	.000	.000
	N	12	12	12
Exp-I	Pearson Correlation	.994**	1	.999**
	Sig. (2-tailed)	.000	.	.000
	N	12	12	12
Exp-II	Pearson Correlation	.994**	.999**	1
	Sig. (2-tailed)	.000	.000	.
	N	12	12	12

** Correlation is significant at the 0.01 level (2-tailed).

Correlation coefficient between the distance run during the Control condition and Experimental condition I is 0.994 **. The correlation is highly significant at .01 level of confidence. Correlation coefficient between the distance run during the Control condition and Experimental condition II is 0.994**. The correlation is highly significant at .01 level of confidence. Correlation coefficient between the distance run during the Experimental condition Experimental condition and I II is 0.999 **. The correlation is highly significant at .01 level of confidence.

Conclusions

1) There was a marked increase in the core temperature proportionate to the increase in the environmental heat index.

2) Core Temperature (Tc) was significantly lower in the conditions Experimental Condition I and

II than the Control condition. Tc during Experimental condition II was less than condition I.

3) Heart Rate (HR) was significantly lower in the Experimental Condition I and II than the Control condition. Heart Rate during Experimental condition II was less than that of condition I.

4) Blood Lactate Level (BL) was significantly lower in the Experimental Condition I and II than in the Control condition. BL during Experimental condition II was less than that of condition I.

5) The total distance run by the subjects before perceived exhaustion increased in the experimental conditions I & II (with cooling jacket), when compared with the control conditions (without jacket). Apart from that, subjects put up a better performance under experimental condition II than condition I.

References

Arngrimsson, S. A., Petitt, D. S., Stueck, M. G., Jorgensen, D. K. & Cureton, K. J. (2004). Cooling vest worn during active warm-up improves 5-km run performance in the heat. *Journal of applied physiology*, 96:1867-1874.

Barwood, M. J., Davey, S., House, J. R., & Tipton, M. J. (2009, November). Post -exercise cooling techniques in hot humid conditions. *European Journal of Applied Physiology*, 107, 4: 385-396.

Dennis, A., CaoGrahnVinh, H., & Heller Craig, H. (2005). Heat extraction through the palm of one hand improves aerobic exercise endurance in a hot environment. *Journal of Applied Physiology*, 99: 972-978.

Duffield, R., & Marino, F.E. (2007, May 3). Effects of pre-cooling procedures on intermittent-sprint exercise performance in warm conditions. *European Journal of Applied Physiology*, 100, 6: 727-735.

Duffield, R., & Marino, F.E. (2008). *Cooling Interventions for the Protection and Recovery of Exercise Performance from Exercise-Induced Heat Stress*. Medicine and Sports Science, 53:89-103.

Duffield, R., Green, R., & Castle, P. (2010, March). *Precooling can prevent the reduction of self-paced exercise intensity in the heat*. Medicine & science in sports & exercise, 42, 3: 577-584.

Goosey-Tolfrey Victoria, Swainson Michelle, Boyd Craig, Atkinson Greg, & Tolfrey Keith. (2008). The effectiveness of hand cooling at reducing exercise-induced hyperthermia and improving distance-race performance in wheelchair and able-bodied athletes. *Journal of Applied Physiology*, 105: 37-43.

Hargreaves, M. (2008, January). *Physiological Limits to Exercise Performance in the Heat*. Sports Medicine, 1:66-71.

Melissa, M. Thomas, Stephen S. Cheung, Geoff C. Elder, and Gordon G. Sleivert. (2005). Voluntary muscle activation is impaired by core temperature rather than local muscle temperature. *Journal of Applied Physiology*, 100: 1361-1369.

Paul C. Castle, Adam L. Macdonald, Andrew Philp, Anthony Webborn, Peter W. Watt, & Neil S. Maxwell (2006). Pre-cooling leg muscle improves intermittent sprint exercise performance in hot, humid conditions. *Journal of Applied Physiology*, 100: 1377-1384.

Quod, M. J., Martin, D. T., Laursen, P. B., Gardner, A. S., HAlson S. L., Marino F.E., Tate, M. P., Mainwaring, D. E., Gore, C. J., & Hahn, A.G. (2008, December). Practical precooling: effect on cycling time trial performance in warm conditions. *Journal of Sports Sciences*, 26, 14:1477-1487.

Racinais, S., Gaoua, N., & Grantham, J. (2008, October 1). Hyperthermia impairs short-term memory and peripheral motor drive transmission. *Journal of Applied Physiology*, 586, 19: 4751-4762.

Randy, E. E. (2010, April). *Body Temperature and Performance*. Current Sports Medicine Reports, 9, 2: 68-69.

Ruth, H. M., Emma, C. L., Philip, W., and Ronald, M. J. (2009, January). *Exercise capacity in the Heat is Greater in the Morning than in the Evening in Man*. Medicine & science in Sports &Exercise, 41, 1: 174-180.

Simmons, S. E, Saxby, B. K., Mcglone, F. P., & Jones, D.A., (2008 September). The Effect of Passive Heating and Head Cooling on Perception, Cardiovascular Function and Cognitive Performance in the Heat. *European Journal of Applied Physiology*, 104, 2: 271-280.

Susan, Y. W., Douglas, C. J., Joseph, M. M., Chad, K. J., Julie, H. C., Josh, G. P., William, H. R., & George, H. R. (2006, May). Body Cooling Between Two Bouts of Exercise in the Heat Enhances Subsequent Performance. *Journal of Strength & Conditioning Research*, 20, 2:

Tate, M., Forster, D., & Mainwaring, D. E (2008, May 6). *Influence of Garment Design on Elite Athlete Cooling*. Sports Technology, 1, 2-3: 117-124.

Tegeder, A. R., Hunter, I., Mack , G.W., & Hager, R. (2008, June). Long Distance Interval Training Following Precooling with an Ice Vest.

International *Journal of Sports Science and Coaching*, 3: 269-275.

Uckert, S., & Joch, W. (2007). Effects of warm-up and precooling on endurance performance in the heat. *British Journal of Sports Medicine,* 41: 380-384.

Vaile, J., Halson, S., Gill, N., & Dawson, B. (2008, March). Effect of Cold-water immersion on repeat cycling performance and thermoregulation in the heat. *Journal of Sports Sciences*, 26, 5: 431-440.

Webborn, N., Price, M. J., Castle, P. C., & Goosey-Tolfrey, V. L. (2005). Effects of two cooling strategies on thermoregulatory responses of tetraplegic athletes during repeated intermittent exercise in the heat, *Journal of Applied Physiology,* 98: 2101-2107.