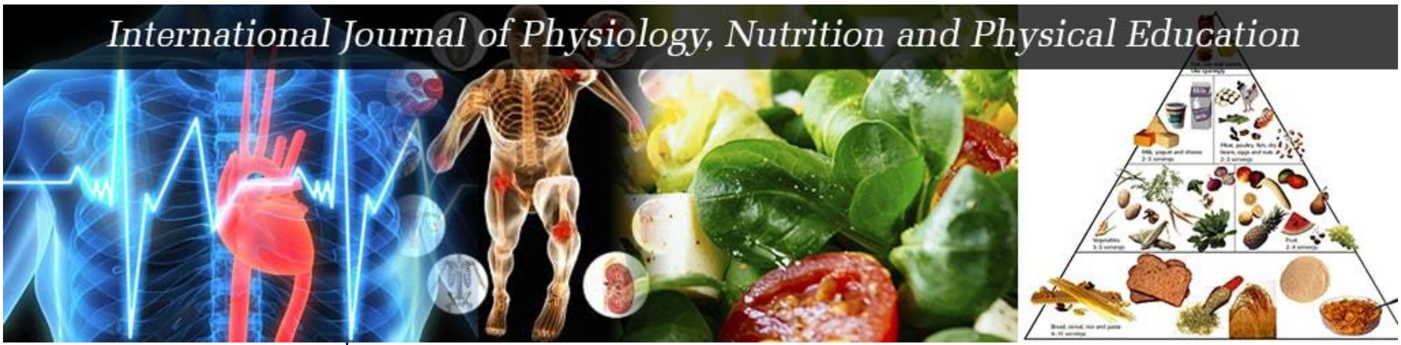

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Comparative effects of cold water immersion, massage and low intensity stretching recovery programmes on selected physiological parameters

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Abstract
The purpose of the study was to compare the effect of different recovery programmes on selected physiological parameters. For the study 08 district level male basketball players aged between 18-23 year, were randomly selected from Birbhum, WB, India. All the subjects were randomly divided in to four groups and each group had two subjects. Experimental Group-I for Massage (MG), Experimental Group-II for Cold Bath (CBG), Experimental group-III for slow stretching Group (STG) and Control group (CG). Three experimental groups were given three different recovery programmes for ten (10) min immediately after the full period basketball match whereas control group not received any recovery training programme except their daily routine.
The subjects on first day played a full period basketball match for 40 min thereafter the Pre-test data was collected immediately after the match. Then on second day the subject again played a full length basketball match and immediately after the match, recovery programmes were applied and then the post test data was collected immediately after the recovery programmes. Blood pressure and VO2max were measured as the physiological variables of the study to analyze the data descriptive statistics and the analysis of co-variance (ANCOVA) at 0.05 level of significance was applied.
The result revealed that there was a insignificant difference in systolic and diastolic blood pressure and VO2max among experimental groups (massage group, cold bath group& slow stretch group) and control group as the calculated 'F' value for systolic & diastolic blood pressure and VO2max was insignificant because p-value associated with these are 0.309 & 0.720 and 0.0475 respectively which were found greater than 0.05. As the calculated 'F' value was found insignificant at 5% level a no post hoc comparison test was applied.

Keywords: physiological variables**,** basketball players, recovery programmes

Introduction
Mechanism of loading in sports training involves application of load as well as recovery process. In fact loading and recovery are considered to be two important aspects of the same unit- training load. Therefore these two processes have been studied and analyzed for understanding their functioning. A sufficient number of research works have conducted to analyze the aspect of loading. On the other hand there are not many investigations to analyze and understand the recovery process. Recovery from exercise or training is an integral component of the overall training program and is essential for optimal performance and improvement. If the rate of recovery is improved, higher training volumes and intensities are possible without the detrimental effects of overtraining (Bishop *et al*., 2008) [5]. As recovery from exercise is significant, personal trainers and coaches use different approaches for the recovery process for clients and athletes. Understanding the physiological concept of recovery is essential for designing optimal training programmes. As well, individual variability exists within the recovery process due to training status (trained vs. untrained), factors of fatigue, and a person's ability to deal with physical, emotional, and psychological stressors (Jeffreys, 2005) [7].

Experimental (Haram *et al*., 2009; Kemi *et al*., 2005), clinical (Helgerud *et al*., 2007; Tjonna *et al*., 2008), and epidemiological (Lee, Sesso, Oguma & Paffenbarger, 2003; Moholdt, Wisloff, Nilsen & Slordahl, 2008) trials in both health and disease show that the beneficial

Effects of Exercise training depend on the intensity at which the exercise training is performed, With high intensity superior to moderate-to-low intensities. Since the high-intensity exercise is performed above the lactate threshold (LT), i.e. the intensity at which lactate starts to accumulate in the skeletal muscle, the exercise is normally carried out in repeated bouts that are interspersed with recovery periods, as in an interval training regime. The reason for the lactate accumulation is that more of the pyruvate is converted to lactate by lactate dehydrogenase (LDH), primarily as a result of changes in the intramuscular redox state, and because oxidation of the excess lactate relies on redistribution by the blood flow to other muscles and the heart and liver (Gladden, 2004; Wasserman, Beaver & Whipp, 1986). Thus, muscle lactate is mirrored by blood lactate.

Since most of the lactate is oxidised by skeletal muscles working at a lower intensity, and since the lactate redistribution occurs via the blood flow (Gladden, 2004), active rather than passive recovery after lactate-accumulating exercise appears to be more effective at clearing accumulated lactate (Belcastro & Bonen, 1975; Boileau, Misner, Dykstra & Spitzer, 1983; Bonen, Campbell, Kirby & Belcastro, 1979; Hermansen & Stensvold, 1972). However, no commonly agreed strategies or optimal intensity of active recovery for clearing accumulated lactate have yet been identified. Previous studies have suggested active recovery intensities in the range 25-63% of the maximal oxygen uptake (*V*O2max), (Boileau *et al*., 1983; Bonen & Belcastro, 1976; Dodd, Powers, Callender& Brooks, 1984; Hermansen&Stensvold, 1972) but these studies quantified the intensity of the active recovery to maximal aerobic capacity (*V*O2max), where lactate production has a non-linear relationship to workload. Only recently have investigators related active recovery 3 intensities to LT (Baldari, Videira, Madeira, Sergio & Guidetti, 2004, 2005; Greenwood, Moses, Bernardino, Gaesser & Weltman, 2008), which may more directly link it to the workload at which production exceeds removal. However, these studies have not studied the intensity-dependence of active recovery in detail, or the temporal characteristics of lactate clearance. It also remain sun clear whether active recovery should be enforced by a set exercise intensity, or whether voluntary control by the individual subject may be optimal (Bonen & Belcastro, 1976).production exceeds removal. However, these studies have not studied the intensity-dependence of active recovery in detail, or the temporal characteristics of lactate clearance. It also remain sun clear whether active recovery should be enforced by a set exercise intensity, or whether voluntary control by the individual subject may be optimal (Bonen & Belcastro, 1976). The present pilot study was taken to investigate comparative effects of different recovery programmes on selected physiological parameters.

Methodology

The study was conducted in a group of 08 district level basketball players aged between 18-23 years were randomly selected from Birbhum, WB, India. Simple random group design method was used for the study and all the subjects were randomly divided in to four groups and each group had two subjects. Experimental Group-I for Massage (MG), Experimental Group-II for Cold Bath (CBG), Experimental group-III for slow stretching Group (STG) and Control group (CG). Three experimental groups were given recovery programmes for ten (10) min immediately after training or competition for basketball players whereas control group not received any recovery training programme except their daily routine.

The subjects on first day played a full length basketball match for 40 min thereafter the Pre-test data was collected immediately after the match. Then on second day the subject again played a full length basketball match and immediately after the match, recovery programmes were applied and then the post test data was collected immediately after the recovery programmes. Blood pressure measurements were taken with a manometer with a stethoscope in the range of measurements 0-300 mm of Hg. VO2max measurement was taken by administering Queens College Step Test on the selected subjects. To analyze data descriptive statistics and the analysis of co-variance (ANCOVA) at 0.05 level of significance was applied.

Results

The data collected was analyzed by using descriptive statistics and scores of post mean of physiological variables are presented in table-1

Table 1: Descriptive statistics of post mean for physiological variables of experimental groups

Variable	Group	Mean	Std. Deviation	N
Systolic blood pressure	Massage Group	110	.00	2
	Cold Water Group	107.50	17.67	2
	Slow Stretch Group	100	14.14	2
	Control Group	110	.000	2
Diastolic blood pressure	Massage Group	80	.000	2
	Cold Water Group	75	7.071	2
	Slow Stretch Group	75	7.071	2
	Control Group	75	.000	2
VO2max	Massage Group	51.69	8.31	2
	Cold Water Group	60.09	1.18	2
	Slow Stretch Group	65.13	1.18	2
	Control Group	68.51	1.15	2

Table 1 depicts that the original post mean for systolic blood pressure of massage group was 110 with a standard deviation of 0.00, cold water group was 107.50 with a standard deviation 17.67, slow stretch group was 100 with a standard deviation 14.14 and control group was 110 with a standard deviation 0.00. The original post mean for diastolic blood pressure of massage group was 80 with a standard deviation of 0.00, cold water group was 75 with a standard deviation 7.07, slow stretch group was 75 with a standard deviation 7.07 and control group was 75 with a standard deviation 0.00.The original post mean for VO2max of massage group was 51.69 with a standard deviation of8.31, cold water group

was 60.09 with a standard deviation 1.18, slow stretch group was 65.13 with a standard deviation 1.18 and control group was 68.51with a standard deviation 1.15.
Thus it was indicating that systolic blood pressure and diastolic blood pressure was found in normal range for all the groups. Whereas VO2max was found grater in massage group.
Descriptive statistics and scores of adjusted post mean of Physiological variables are presented in table-2

Table 2: Descriptive statistics of adjusted post mean for physiological variables of experimental groups

Variable	Group	Mean	Std. Error	95% Confidence Interval Lower Bound Upper Bound	
Systolic blood Pressure	Massage Group	113.12	5.95	94.18	132.06
	Cold Water Group	108.12	5.78	89.72	126.52
	Slow Stretch Group	93.12	6.58	72.15	114.09
	Control Group	113.12	5.95	94.18	132.06
diastolic blood pressure	Massage Group	78.50	3.33	67.88	89.11
	Cold Water Group	77.50	3.62	65.97	89.05
	Slow Stretch Group	73.50	3.33	62.88	84.11
	Control Group	75.50	3.18	65.37	85.62
VO2max	Massage Group	54.53	4.32	40.77	68.28
	Cold Water Group	61.04	3.23	50.73	71.34
	Slow Stretch Group	64.56	3.13	54.59	74.54
	Control Group	65.28	4.62	50.57	79.99

Table 2 revealed that the adjusted post mean for systolic blood pressure of massage group was 113.12, cold water group was 108.12, slow stretch group was 93.12 and control group was 113.12. The adjusted post mean for diastolic blood pressure of massage group was 78.50, cold water group was 77.50, slow stretch group was 73.50 and control group was 75.50. The adjusted post mean for VO2max of massage group was 65.28, cold water group was 61.04, slow stretch group was 64.56 and control group was 54.53.
It was very clear that adjusted post mean of systolic and diastolic blood pressure was found lowest in slow stretch group and VO2max was found lowest in massage group.
The analysis of covariance (ANCOVA) was used to find out the significant difference between experimental groups & control group after eliminating the effects of covariate is presented in table-3.

Table 3: Analysis of covariance for between subject effects among experimental groups

Variable	Source	Type I Sum of Squares	df	Mean Square	F Ratio	Sig. level (p-value)
Systolic blood Pressure	Pre test	71.001	1	71.001	1.065	.378
	Treatment Group	375.87	3	125.291	1.87	.309
	Error	200.00	3	66.667		
	Corrected Total	646.87	7			
Diastolic blood Pressure	Pre-Test	48.790	1	48.790	2.440	.216
	Treatment Group	28.71	3	9.57	478	.720
	Error	60.00	3	20.00		
	Corrected Total	137.5	7			
VO2max	Pre-Test	276.085	1	276.085	14.594	.032
	Treatment Group	61.39	3	20.40	1.082	.475
	Error	56.75	3	18.91		
	Treatment Group	394.23	7			

MM* Significant at 5% level.
$F_{.05}$ (3, 3) = 9.28

Table-3 clearly revealed that there was a statistically insignificant difference in systolic &diastolic blood pressure and VO2max among experimental groups (massage group, cold stretch group& slow stretch group) and control group as the calculated 'F' value for systolic & diastolic blood pressure and VO2max was insignificant because p-value associated with these are 0.309 & 0.720 and 0.0475 respectively which were found greater than 0.05.
This proved that there was a no significant difference among the means due to different recovery training programs on systolic blood pressure, diastolic blood pressure and VO2 max.
As the calculated 'F' value was found insignificant at 5% level a no post hoc comparison test was applied.
The graphical representation of post-group means of experimental groups and control group for physiological variables are presented in Figure-1.

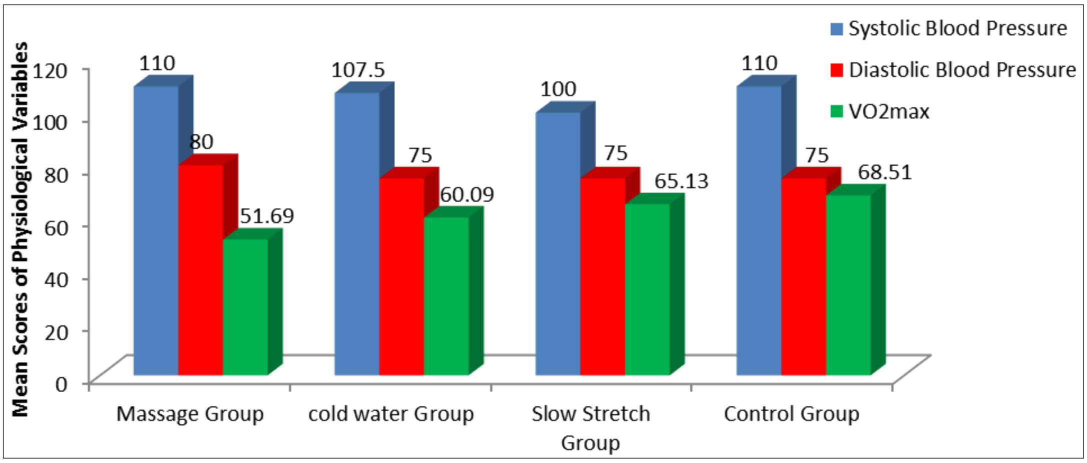

Fig 1: Graphical Comparison of the Mean of Physiological variables of Experimental Groups & Control Group.

Discussion

This study investigated comparative effects of different recovery programmes on selected physiological parameters of basketball players. No significant change was found in systolic and diastolic blood pressure and VO2max among basketball players after administration of different recovery programs (Massage, cold water & slow stretch recovery programs). It may be attributed due to the fact that the all the recovery programmes were administered only for the duration of ten minutes which might not be appropriate to produce significant changes in all physiological variables among different recovery programs. It was very clear from the adjusted post mean systolic and diastolic blood pressure was found lowest in slow stretch group and VO2max was found lowest in massage group. For the fast and better recover of basketball players it was found massage recovery programme was better than other recovery programme in case of VO2max whereas slow stretch recovery programme was more effective than massage and cold water recovery programme in case of mean systolic and diastolic blood pressure.

Recovery is a critical part of training as it is used to minimize the risk of overtraining and injury, while its promoting physical and psychological readiness. Numerous research supports the use of cold water immersion for reducing the effects of subjective measures post-exercise (i.e. DOMS and RPE), its effects on objective measures are far less apparent (Hohenauer *et al*., 2015) [1]. Finding of this study are consistent with Olney (2005) [2], Hernandez-Reif *et al*. (2000) [3] and Moeini *et al*. (2011) [4] showed no significant changes in Systolic blood pressure of their control groups.

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