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Study of biochemical responses to sprint swimming and long-distance swimming and variations in these responses during different training seasons

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■ **ABSTRACT**

The biochemical responses to any exercise activity are extremely important indicators of the quantity and quality of training being given to the sports person. The chief purpose of present study was to analyze the biochemical responses to sprint swimming and long-distance swimming and variations in these responses during different training seasons. For this purpose, the subjects were assigned to two groups. "Group A" was of sprint swimmers and "Group B" was of long-distance swimmers. Each group consisted of thirty subjects. For each group, subjects were selected by using "Random sampling method" from the available trained level swimmers. The duration of experimental period was of sixteen weeks. This period was divided into three seasons. These seasons were: Preparatory season, Peak season and Taper season. The biochemical tests were done after collecting blood samples of subjects. The difference in biochemical responses before and after activity was tested. Such tests were carried out in the beginning *i.e.* start of the experimental programme and at the end of each training season and the variations in these responses were tested. The results of the group of sprint swimmers indicated that, there is no significant difference in pre-swimming and post-swimming total cholesterol levels at all stages of the experiment. But observation of variations in these responses during different training seasons indicates that, the total cholesterol level decreased gradually during each season. The greatest decrease in total cholesterol level was observed at the end of peak season in both groups.

■ **KEY WORDS :** Sprint swimming, Long-distance swimming, Training periods, Cholesterol

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Swimming is one of the most physiologically exacting sport: the tournament competitive schedules of top swimmers and their training programmes are arguably more severe than any other sports (Cecil, 1992).

Periodization is the division of the training year into periods so as to systematically prepare and develop sports form and skills as well as moral and will qualities for the forthcoming competitions (James, 1989).

As a consequence of 10-year prospective experimental research, at present, there may be no suitable, single, simple hematological, biochemical or

hormonal answer to the question "how to monitor training to avoid overtraining". Thus, the "multiple parameter diagnostic approach" for this purpose may prove to be effective. In overtraining at medium to high caloric demands, beside performance incompetence, an early overtraining syndrome may be indicated by a "diagnostic multiple parameter approach" which includes different biochemical and hematological approach (Lehmann *et al.*, 1998).

Statement of the problem :

The techniques like biochemical analysis can be used successfully for better management of training programmes and imparting more effective and science-based coaching to athletes. To fulfill this objective, the researcher undertook following problem for his research study.

"The study of biochemical responses to sprint swimming and long-distance swimming and variations in these responses during different training seasons"

Significance of the study :

– To study and evaluate the immediate biochemical responses during anaerobic physical activity and aerobic physical activity and to evaluate variations in these responses during different training seasons.

– Even though, biochemical responses play vital role in proper conditioning and training, very much stress is given on training schedules and coaching techniques today. Very few studies have been reported on this crucial aspect of performance. This study may contribute in filling real gap of knowledge.

– The present study may serve following purposes.

- Evaluation of the effects of changes in lipid profile on cardio-vascular fitness and heart-related risks and utilization of fat as energy source.

Purpose of the study :

The chief purpose of present study was to analyze the biochemical responses to sprint swimming and long-distance swimming and variations in these responses during different training seasons.

Hypothesis :

For the present study, the researcher hypothesized that there will be significant variations in biochemical responses to sprint swimming and long-distance swimming and there will be significant variations in these responses during different training seasons as well.

Delimitations :

The study was delimited to following criteria.

– The subjects were selected from Authorized coaching center where swimmers regularly practice throughout the season.

– Those swimmers who have specialized in sprint swimming and long-distance swimming were selected.

– The study was delimited to sprint swimming (50 meters) and long-distance swimming (1500 meters) for assessing the biochemical responses.

– The swimming stroke selected for present study was crawl *i.e.* free style stroke for both sprint swimmers and long-distance swimmers.

– The experimental programme was of sixteen weeks duration.

– Totals of sixty subjects were selected out of which thirty subjects were sprint swimmers and thirty subjects were long-distance swimmers.

– The average age of subjects was 19 ± 4 years.

– Only male subjects were selected.

– The number of training sessions was two per day *i.e.* morning session and evening session.

– The experimental programme comprised preparatory season, peak season and taper season.

– The biochemical responses were analyzed using scientific procedures and equipments only.

– The present study was delimited to selected biochemical parameters only.

– Those swimmers who are training for middle-distance swimming were not included in this study.

– The biochemical responses during the off season were not measured.

Limitations :

– There was no strict control on diet, rest and sleep etc. of subjects but the subjects were only instructed and guided to have standard nutritious diet.

– Regulation of daily-life activities of the subjects was beyond scope of this study.

– The subjects were not selected on the basis of baseline physiological capacity of subject.

– The subjects were prohibited from undergoing any special training or from taking any ergogenic aids to

improve their performance.

– There are certain factors that can influence the composition of body fluids such as circadian variations, race, posture, heredity etc. These factors are beyond the control of researcher, so these factors were not taken into consideration.

– Climatic variations during the study were out of control of this study.

– No special techniques other than prescribed analytical techniques were employed to get results while measurements are being taken.

Definitions of operational terms :

Cholesterol :

Cholesterol and cholesteryl esters are essentially insoluble in water. In order to transport these compounds around the body in the blood, the liver and intestine produce various lipid-protein complexes, called lipoproteins, which serve to solubilize them. Lipoproteins are large, complex mixtures of cholesterol, cholesteryl esters, phospholipids, triglycerides (fats), and various proteins. The major lipoproteins include chylomicrons, very-low-density lipoprotein (VLDL), low-density lipoprotein and high-density lipoprotein (HDL). Total plasma cholesterol levels of less than 200 mg/100 ml are considered desirable (Sci-Tech Encyclopedia.com).

■ METHODOLOGY

Procedure of experiment :

After considering all the above guidelines by the eminent researchers in the field of training, the researcher prepared and followed following experimental programme for the present study.

The duration of experimental period was of sixteen weeks. This period was divided into three seasons. These seasons were: Preparatory season, Peak season and Taper season.

The duration of preparatory season was of eight weeks. The duration of peak season was of six weeks. The duration of Taper season was of two weeks. During this complete period all subjects were divided into two groups of thirty subjects each. "Group A" was of sprint swimmers and "Group B" was of long-distance swimmers. All these swimmers were assigned to training programme according to their specific events for which they are training.

All swimmers were asked to report for their respective workouts on all weekdays according to their respective training programme. The training was given in two sessions per day *i.e.* morning session and evening session. Each training session lasted for approximately 2-3 hours daily. The workload for each group varied depending upon their respective events and training season.

The biochemical tests were done after collecting blood samples of subjects. The difference in biochemical responses before and after activity was tested. Such tests were carried out in the beginning *i.e.* start of the experimental programme and at the end of each training season and the variations in these responses were tested.

Experimental design :

The subjects were assigned to two groups. "Group A" was of sprint swimmers and "Group B" was of long-distance swimmers. Each group consisted of thirty subjects. For each group subjects were selected by using "Random sampling method" from the available trained level swimmers. The difference in mean scores obtained from tests taken in beginning *i.e.* start of experiment and at the end of each training season was tested for significance of difference by using "F test". The level of significance was set at 0.05 (Jack and James, 1991).

Data collection :

The data was collected from the results of biochemical analysis of blood samples of subjects. For biochemical data, the blood samples of approximately 10 ml. were obtained from forearm *i.e.* antecubital vein of subject at swimming pool. These blood samples were then tested using standard instruments and procedures. Fasting, early morning blood samples were collected. The pre-swimming and post-swimming samples were obtained from both sprint and long-distance swimmers. Such blood samples were collected in the beginning *i.e.* start of experiment and at the end of each training season. After testing these blood samples using scientific equipments and procedures, the data was obtained. This data then was tested for significance of difference using appropriate statistical techniques.

Selection of parameters :

The following parameter was selected as Biochemical Parameter.

Total cholesterol :
Selection of tests :

The tests selected for accurate measurement of biochemical responses were based on regular scientific practices, suggestions and guidance taken from guide and suggestions from experts working in the field of sports medicine and biochemistry.

Biochemical tests :

For this purpose, the blood samples collected from both sprint and long-distance swimmers were subjected to following tests and the results were analyzed to investigate variations in these results at various stages during the experiment.

Cholesterol :

Chod-PAP method end point with lipid clearing agent (Allain *et al.*, 1974 and Roeschlau *et al.*, 1974).

Descriptions of test instruments :

Miura biochemistry auto analyzer (*www.logotech-ise.com*)*:*

Miura is the new random access analyzer developed by I.S.E. Group that supplies more than 5,000 customers all over the world.

■ OBSERVATIONS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Analysis and interpretation of data :

After completion of experiment on "The study of biochemical responses to sprint swimming and long-distance swimming and variations in these responses during different training seasons", the statistical analysis of data collected on "Group A" of sprint swimmers and "Group B" of long-distance swimmers with thirty swimmers in each group trained during complete experimental programme of sixteen weeks was done and is presented in this paper.

The findings of this experimental programmes are statistically analyzed, interpreted and presented using various presentation techniques.

Statistical methods :

As mentioned above, the pre-swimming and post-swimming data of biochemical responses was collected from both sprint and long-distance swimmers in the beginning of experiment and at the end of each training season.

To determine the significance of difference (ANOVA) among the means of the data collected from group of sprint swimmers and long-distance swimmers taken at different stages of experiment (*i.e.* at the start of experiment and at the end of each training season), the "F" test was employed as statistical method. Appropriate Post-hoc tests were employed to test the difference. The level of significance of difference was set at 0.05.

To determine the significance of difference (ANOVA) among the means of the data collected from group of sprint swimmers taken before swimming *i.e.* pre-swimming and after swimming *i.e.* post-swimming at different stages of the experiment (*i.e.* at the start of experiment and at the end of each training season), the "F" test was employed as statistical method. Appropriate Post-hoc tests were employed to test the difference. The level of significance of difference was set at 0.05.

To determine the significance of difference (ANOVA) among the means of the data collected from group of long-distance swimmers taken before swimming *i.e.* pre-swimming and after swimming *i.e.* post-swimming at different stages of the experiment (*i.e.* at the start of experiment and at the end of each training season), the "F" test was employed as statistical method. Appropriate Post-hoc tests were employed to test the difference. The level of significance of difference was set at 0.05.

To determine the difference (ANOVA) between the means of the pre-swimming and post-swimming data collected at each stage of the experiment (*i.e.* at the start of experiment and at the end of each training season), appropriate Post-hoc tests were employed as statistical method. The level of significance of difference was set at 0.05.

The data collected during the experiment was statistically analyzed using appropriate statistical procedures. After statistically analyzing the collected data findings were drawn. The findings of this experimental programme were statistically analyzed, interpreted and are presented using various presentation techniques in this paper.

Following abbreviations have been used to indicate

different stages of training seasons during which data collection has been done. The full forms of these abbreviations are as follows.

– STAPRE - Pre swimming at the start of experiment

– STAPOST - Post swimming at the start of experiment.

– PREPRE - Pre swimming at the end of preparatory season

– PREPOST - Post swimming at the end of preparatory season

– PEAKPRE - Pre swimming at the end of peak season

– PEAKPOST - Post swimming at the end of peak season

– TAPERPRE - Pre swimming the end of taper season

– TAPERPOST - Post swimming at the end of taper season

Total cholesterol :

(*Sprint swimmers*) :

To determine the significance of difference (ANOVA) among the means of the data collected from group of sprint swimmers taken before swimming *i.e.* preswimming and after swimming *i.e.* postswimming at different stages of the experiment (*i.e.* at the start of experiment and at the end of each training season), the "F" test was employed as statistical method. Tukey-Kramer Multiple Comparisons Test was employed as Post-Hoc test to determine the significance of difference between the means of the data collected from the group at different stages of the experiment. The level of significance of difference was set at 0.05 (Fig. 1).

From the analysis of variance of the total cholesterol test data collected at different stages of experiment, it was observed that the obtained "F" *i.e.* 11.876 is greater than the tabulated "F" *i.e.* 2.01 at 0.05 level of significance with df_{bet} 7 and df_{within} 232. This indicates that there is significant difference among the means the data collected from the group of sprint swimmers taken at different stages of the experiment.

Tukey-Kramer Multiple Comparisons test was employed as Post-Hoc test to determine the significance of difference between the means of the data collected from the group at different stages of the experiment. Following table presents the results of Tukey-Kramer Multiple Comparisons Test.

Total cholesterol :

(*Long-distance swimmers*) :

To determine the significance of difference (ANOVA) among the means of the data collected from group of long-distance swimmers taken before swimming *i.e.* preswimming and after swimming *i.e.* post swimming at different stages of the experiment (*i.e.* at the start of experiment and at the end of each training season), the "F" test was employed as statistical method. Tukey-Kramer Multiple Comparisons Test was employed as Post-Hoc test to determine the significance of difference between the means of the data collected from the group at different stages of the experiment. The level of significance of difference was set at 0.05 (Fig. 2).

From the analysis of variance of the total cholesterol test data collected at different stages of experiment, it was observed that the obtained "F" *i.e.* 10.707 is greater than the tabulated "F" *i.e.* 2.01 at 0.05 level of significance with df_{bet} 7 and df_{within} 232. This indicates that there is significant difference among the means the data collected from the group of long-distance swimmers taken at different stages of the experiment.

Tukey-Kramer Multiple Comparisons Test was employed as Post-Hoc test to determine the significance of difference between the means of the data collected

Table 1 : Means of the total cholesterol test data collected at different stages of experiment

Test	Stapre	Stapost	Prepre	Prepost	Peakpre	Peakpost	Taperpre	Taperpost
Mean	154.73	156.57	150.90	152.73	148.40	150.43	149.77	151.47

Table 2 : Analysis of variance of the total cholesterol test data collected at different stages of experiment

Source of variation	DF	SS	MS	F
Between groups	7	1519.0	217.01	11.876
Within groups	232	4239.2	18.272	
Total	239	5758.3		

N = 240 Level of significance = 0.05

from the group at different stages of the experiment. Following table presents the results of Tukey-Kramer Multiple Comparisons Test.

Statistical analysis of data presented in Tables 1 and 2 indicate that, there is statistically significant difference among the means of the total cholesterol test data collected from the group of sprint swimmers taken at different stages of the experiment. Similarly, statistical analysis of data presented in Tables 4 and 5 indicate that, there is statistically significant difference among the means of the total cholesterol test data collected from the group of long-distance swimmers taken at different stages of the experiment.

Thus, after analyzing the data obtained during the experiment statistically and interpreting it, the researcher concludes that the hypothesis proposed by him has been accepted successfully.

Statistical analysis presented in Table 3 indicate the results of Post-hoc test of the total cholesterol test data from the group of sprint swimmers collected at different stages of experiment. Likewise, statistical analysis presented in Table 6 indicate the results of Post-hoc test

Table 3 : Results of post-hoc test of the total cholesterol test data collected at different stages of experiment

Test	SIG	Test	SIG	Test	SIG	Test	SIG
Stapre vs Stapost	NS	Stapost vs Prepre	***	Prepre vs Peakpre	NS	Prepost vs Taperpost	NS
Stapre vs Prepre	*	Stapost vs Prepost	*	Prepre vs Peakpost	NS	Peakpre vs Peakpost	NS
Stapre vs Prepost	NS	Stapost vs Peakpre	***	Prepre vs Taperpre	NS	Peakpre vs Taperpre	NS
Stapre vs Peakpre	***	Stapost vs Peakpost	***	Prepre vs Taperpost	NS	Peakpre vs Taperpost	NS
Stapre vs Peakpost	**	Stapost vs Taperpre	***	Prepost vs Peakpre	**	Peakpost vs Taperpre	NS
Stapre vs Taperpre	***	Stapost vs Taperpost	***	Prepost vs Peakpost	NS	Peakpost vs Taperpost	NS
Stapre vs Taperpost	NS	Prepre vs Prepost	NS	Prepost vs Taperpre	NS	Taperpre vs Taperpost	NS

where

>0.05	Not significant	NS
0.01 to 0.05	Significant	*
0.01 to 0.001	Very significant	**
< 0.001	Extremely significant	***

Table 4 : Means of the total cholesterol test data collected at different stages of experiment

Test	Stapre	Stapost	Prepre	Prepost	Peakpre	Peakpost	Taperpre	Taperpost
Mean	150.73	151.63	146.90	147.73	144.40	145.43	145.77	146.47

Table 5 : Analysis of variance of the total cholesterol test data collected at different stages of experiment

Source of variation	DF	SS	MS	F
Between groups	7	1373.9	196.28	10.707
Within groups	232	4252.8	18.331	
Total	239	5626.7		

N = 240 Level of significance = 0.05

Table 6 : Results of post-hoc test of the total cholesterol test data collected at different stages of experiment

Test	SIG	Test	SIG	Test	SIG	Test	SIG
Stapre Vs Stapost	NS	Stapost Vs Prepre	***	Prepre Vs Peakpre	NS	Prepost Vs Taperpost	NS
Stapre Vs Prepre	*	Stapost Vs Prepost	*	Prepre Vs Peakpost	NS	Peakpre Vs Peakpost	NS
Stapre Vs Prepost	NS	Stapost Vs Peakpre	***	Prepre Vs Taperpre	NS	Peakpre Vs Taperpre	NS
Stapre Vs Peakpre	***	Stapost Vs Peakpost	***	Prepre Vs Taperpost	NS	Peakpre Vs Taperpost	NS
Stapre Vs Peakpost	***	Stapost Vs Taperpre	***	Prepost Vs Peakpre	NS	Peakpost Vs Taperpre	NS
Stapre Vs Taperpre	***	Stapost Vs Taperpost	***	Prepost Vs Peakpost	NS	Peakpost Vs Taperpost	NS
Stapre Vs Taperpost	**	Prepre Vs Prepost	NS	Prepost Vs Taperpre	NS	Taperpre Vs Taperpost	NS

where

>0.05	Not significant	NS
0.01 to 0.05	Significant	*
0.01 to 0.001	Very significant	**
< 0.001	Extremely significant	***

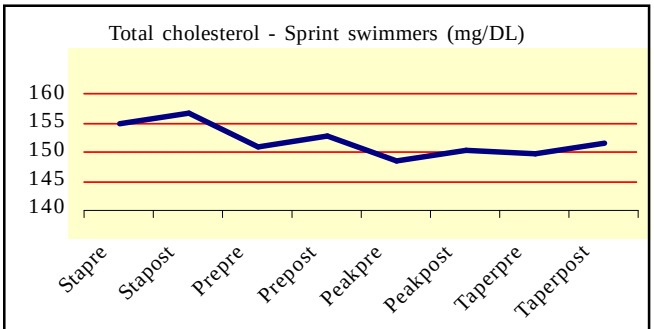

Fig. 1 : Means of the total cholesterol test data collected at different stages of experiment in sprint swimmers

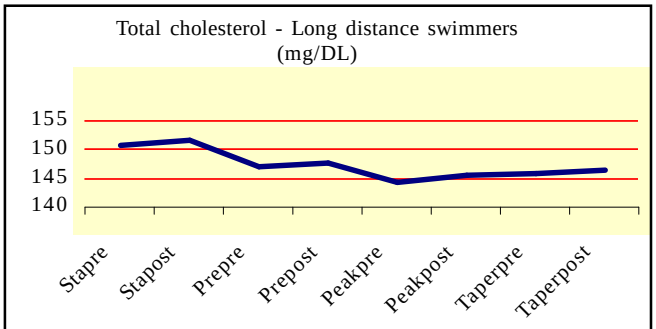

Fig. 2 : Means of the total cholesterol test data collected at different stages of experiment in long distance swimmers

of the total cholesterol test data from the group of long-distance swimmers collected at different stages of experiment. The findings drawn from these tables are as follows.

The results of the group of sprint swimmers indicate that, there is no significant difference in pre-swimming and post-swimming total cholesterol levels at all stages of the experiment. This indicates that, there is no variation in total cholesterol level in response to single bout of sprint swimming. But observation of variations in these responses during different training seasons indicates that, the total cholesterol level decreased gradually during each season. The greatest decrease in total cholesterol level was observed at the end of peak season.

Similarly, the results of the group of long-distance swimmers indicate that, there is no significant difference in pre-swimming and post-swimming total cholesterol levels at all stages of the experiment. This indicates that, there is no variation in total cholesterol level in response to single bout of long-distance swimming also. But observation of variations in these responses during different training seasons indicates that, the total cholesterol level decreased gradually during each season. The greatest decrease in total cholesterol level was observed at the end of peak season.

Thus, it can be concluded that, a single bout of neither sprint swimming nor long-distance swimming significantly affects total cholesterol levels. This may be because, even though, long-distance swimming depends to some extent on fats as source of energy but it does not put heavy demands on stored fats for energy source. But, total cholesterol levels vary during different training seasons. The variations were greatest during peak season. This may due to heavy training volume and intensity during peak season leading to utilization of stored fat. This indicates that, during activity of shorter duration, fat is not the primary source of energy but as the duration of activity increases dependence on fat as energy source increases.

Conclusion :

At the conclusion of experiment, from the results of study, under the conditions of present experiment, the researcher has presented conclusions drawn from the study.

After statistically analyzing the data of the total cholesterol test collected from the group of sprint swimmers and the group of long-distance swimmers at different stages of experiment, it was observed that the obtained "F" is 11.876 and 10.707, respectively, which is greater than the tabulated "F" *i.e.* 2.01 at 0.05 level of significance with df_{bet} 7 and df_{within} 232. This indicates that there is significant difference among the means the data collected from the group of sprint swimmers as well as long-distance swimmers taken at different stages of the experiment.

Thus, after analyzing the data obtained during the experiment statistically and interpreting it, the researcher concludes that the hypothesis proposed by him has been accepted successfully.

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