Relationship of Selected Physiological Variables with Swimming Performance of Male Age Group Swimmers

Dr Amrish Tony*

ABSTRACT

The aim of the present study was to find out the relationship of selected physiological variables with Swimming performance. Ninety male age group (9-10 years, 11-12 years and 13-14 years) swimmers, undergoing training under specialised coaches, were selected for the present study. The physiological variables selected for the present study included back strength, grip strength, maximum oxygen consumption (VO_2 max), oxygen debt, maximum heart rate and recovery heart rate. Measurement for VO_2 max was done by Gas Analyser (Oxycon Champion, Erich Jaeger, Germany) and exercise was done on computerised motor driven treadmill (Erich Jaeger, Germany). Oxygen debt was calculated from recovery oxygen consumption. Heart rate was measured by on-line ECG Monitor. Back and grip strength were taken by back and grip dynamometers, respectively. Swimming performance was evaluated by 50 meter free style Swimming time. Correlation coefficient among back strength, grip strength, maximum oxygen consumption (VO_2 max), maximum heart rate, recovery heart rate and Swimming performance variables were computed by using standard statistical package SPSS.

Analysis of the results indicated that back strength, grip strength, maximum oxygen consumption, oxygen debt and recovery heart rate are significantly correlated with Swimming performance, in all the three age groups. From the

*Deputy Director, Deptt. of Physical Education, S.R.M. University, Sonepat (Haryana)
e-mail: coach_tony@live.com

above findings, it can be concluded that apart from techniques and tactics, the physiological attributes play an important role in swimming performance. Regular monitoring of these variables can help the young swimmers to know their status and the areas to be improved, which can help them achieve excellence at higher levels of competition. Although, the swimmers may be having similar quality of techniques and skills, but those having better physiological qualities can obviously perform better.

INTRODUCTION

Most animals swim by instinct. Even those who do not really like water can swim at their first attempt by performing their accustomed movements of swimming. On the other hand, man has to be taught this art and he finds the process of learning to swim somewhat artificial, in spite of the fact that water is the first natural element for man. Swimming, which was considered to be only a survival activity, has now developed into one of the most popular competitive sport at the international and Olympic level. This is perhaps one of the few sports where increasing performances are evident, now and then; and swimmers have attained incredible standards at a relatively much younger age. One factor of such a high performance is the human organism which is organically and physically in a state of readiness even just a few months after the birth; which is not true in the case of other sports, where a certain level of physical and mental maturity is necessary, before one can understand such sports.

Swimming, at the competitive level, depends on various factors like physical, physiological, biochemical, biomechanical and psychological. Among physiological characteristics, physical work capacity is the most important. This is reflected by aerobic and anaerobic capacity of swimmers (Khanna & Saha, 1992). Number of studies have been conducted on the physiological characteristics of the champion and age-group swimmers (Holmer et al, 1974; Magel & Faulkner, 1967). The need for scientific selection and training of athletes, at young age, has attracted the attention of the exercise physiologists to study physiological responses to exercise in children, during the growth period (Bar Or, 1973; Rode & Shepard, 1973; Howald et al, 1974; Ichikawa & Miyashita, 1980; Bar Or, 1983; Rowland, 1985; Voccaro & Mahon 1987). Energy production for metabolic activities can, in general terms, be devided into aerobic and anaerobic components. In man, maximal aerobic power has been used as a criterion to study the efficiency and performance, and performance capacity of the aerobic energy component (Hollmann et al, 1964; Saltin & Astrand, 1967; Gollnick et al, 1972; Berg 1974). Amongst the physiological characteristics, strength and aerobic and anaerobic components are most important. Again, these components can be assessed by different physiological parameters

Like back strength, VO_2 max, O_2 debt and recovery heart rate, which play a vital role in improving sports performance. The aim of the present study is to to establish relationship of selected physiological variables to Swimming performance of age group swimmers. The present study also aimed to find out the potential deficiencies, if any; and to undertake remedial measures to overcome the training stresses. The physiological variables obtained from this study will enable us to find out the physiological status of the young swimmers. The finding of the present study can be compared with the International counterparts, which will help to set the target for future goal. The study may provide information about the physiological variables to the swimming performance of various age group swimmers. It may help to set up the target of physiological variables to be achieved, keeping in view the physiological demand of swimming. This study will also help the coaches and physical educationists in formulating appropriate training programme, for the age group swimmers.

METHODOLOGY

The present study was conducted on 90 age group male swimmers of 9 to 10, 11 to 12 and 13 and 14 years. The subjects were selected from different Swimming pools of Bangalore city. The level of performance of the subjects was national level. In the present study, physiological functions were measured in the laboratory in terms of back and grip strength, oxygen consumption and heart rate which are again dependent on other coordinated physiological functions, particularly of circulatory, respiratory and muscular systems. For this purpose, back strength, grip strength, maximum oxygen consumption (VO_2 max) maximum and recovery heart rate were measured. Measurements for VO_2 max was done by Gas Analyser (Oxycon Champion, Erich Jaeger, Germany) and exercise was done on computerised motor driven treadmill (Erich Jaeger, Germany). Heart rate was measured by ECG Monitor. Back and grip strength were taken by back and grip dynamometers, respectively (Senoh, Japan). Fifty metres swimming timing, for all the swimmers, were taken with the help of stop watch. From the timing the speed was also calculated. Correlation co-efficient was computed to find out the relationship among the above-mentioned physiological parameters and swimming performance. The above analysis was done using standard statistical package SPSS.

RESULTS & DISCUSSION

The statistical analysis of data on selected physiological variables are presented in this section. The data obtained on physiological and performance variables have been analysed by Pearson's Product Moment Correlation, in order to determine the relationship of physiological variables to performance of swimmers of different age groups.

Intercorrelation between physiological variables and performance of 9-10 years age group swimmers is presented in Table 1.

Table-1 : Correlation Matrix of Physiological Variables and Performance of 9-10 Years Age Group Swimmers

	VO_2max (l/min)	VO_2max (ml/kg/min)	O_2 debt (l)	Maximum heart rate (bpm)	Recovery heart rate (bpm)
VO_2max (ml/kg/min)	0.857*				
O_2 debt (l)	0.657*	0.582*			
Maximum heart rate (bpm)	-0.501*	-0.498*	0.511*		
Recovery heart rate (bpm)	-0.592*	-0.612*	0.123	0.126	
50 meter timing(second)	-0.652*	-0.587*	-0.543*	0.244	0.765*

*Signficant at $p<0.05$

Table 1 reveals that, in case of 9-10 years age group, Swimming performance is significantly correlated to the physiological variables like VO_2max (l/min), VO_2max (ml/kg/min), O_2 debt and recovery heart rate. The Table also reveals that significant correlations are found between both the VO_2max. O_2debt is significantly correlated with both the VO_2max and maximum heart rate. Both maximum heart rate and recovery heart rate are significantly correlated with both the VO_2 max (l/min and ml/kg/min). There was no significant correlation between Swimming performance and maximum heart rate. No significant correlation was found between maximum heart rate and recovery heart rate.

Correlation matrix of physiological variables and performance of 11-12 years age group swimmers is presented in Table 2.

Table-2 : Correlation Matrix of Physiological Variables and Performance of 11-12 Years Age Group Swimmers

	VO_2max (l/min)	VO_2max (ml/kg/min)	O_2 debt (l)	Maximum heart rate (bpm)	Recovery heart rate (bpm)
VO_2max (ml/kg/min)	0.789*				
O_2 debt (l)	0.601*	0.539*			
Maximum heart rate (bpm)	-0.493*	-0.458*	0.497*		
Recovery heart rate (bpm)	-0.538*	-0.654*	0.141	0.098	
50 meter timing(second)	-0.468*	-0.521*	-0.495*	0.197	0.689*

*Signficant at $p<0.05$

Table 2 reveals that, in case of 11-12 years age group, Swimming performance was significantly correlated with VO_2max (l/min), VO_2max (ml/kg/min), O_2 debt and recovery heart rate. The Table also reveals that significant correlations were found between both the VO_2max. O_2debt was significantly correlated with both the VO_2max and maximum heart rate. Both maximum heart rate and recovery heart rate were significantly correlated with both the VO_2 max (l/min and ml/kg/min). There was no significant correlation between swimming performance and maximum heart rate. No significant correlation was found between maximum heart rate and recovery heart rate.

Correlation matrix of physiological variables and performance of 13-14 years age group swimmers is presented in Table 3.

Table-3 : Correlation Matrix of Physiological Variables and Performance of 13-14 Years Age Group Swimmers

	VO_2max (l/min)	VO_2max (ml/kg/min)	O_2 debt (l)	Maximum heart rate (bpm)	Recovery heart rate (bpm)
VO_2max (ml/kg/min)	0.721*				
O_2 debt (l)	0.567*	0.512*			
Maximum heart rate (bpm)	-0.481*	-0.439*	0.439*		
Recovery heart rate (bpm)	-0.554*	-0.617*	0.157	0.087	
50 meter timing(second)	-0.471*	-0.567*	-0.465*	0.156	0.653*

*Significant at $p<0.05$

Table 3 revealed that in case of 13-14 years age group, Swimming performance was significantly correlated with VO_2max (l/min), VO_2max (ml/kg/min), O_2debt and recovery heart rate. The Table also revealed that significant correlations were found between both the VO_2max. O_2debt was significantly correlated with both the VO_2max and maximum heart rate. Both maximum heart rate and recovery heart rate were significantly correlated with both the VO_2 max (l/min and ml/kg/min). There was no significant correlation between Swimming performance and maximum heart rate. No significant correlation was found between maximum heart rate and recovery heart rate.

The physiological variables depicted that, in case of all the three age groups, Swimming performance was significantly correlated with the physiological variables like VO_2max (l/min), VO_2max (ml/kg/min), O_2 debt and recovery heart rate. In many sports or events, endurance base is required for better fitness and faster recovery. In the present study, it is evident that VO_2max and recovery heart rate was significantly correlated. In the present study, the significant relationship was found between VO_2max and 50 meter Swimming performance; which was probably due to the dominance of aerobic metabolism in these particular age groups (9-14 years).

One aspect of the aerobic system is its capability to pay-back anaerobic energy use while recovering. Reviewing the nature of oxygen consumption, during recovery, provides a window into some of the non-aerobic energy functions that occur during a performance (Brent,2009). Post-performance oxygen consumption restores the portion of anaerobic processes used while exercising, that was not restored/cleared during the exercise. The post-performance consumption curve has two parts. First, the "fast-component" is used to restore muscle phosphagen compounds (ATP-CP). That restoration occurs very rapidly and rarely exceeds 30 seconds. Second, the "slow-component" occurs during recovery and initially overlaps with the fast-component. It removes lactate and other compounds associated with the use of glycogen as well as restoring temperature, hormonal balance, etc. The degree that post-exercise oxygen consumption remains above normal suggests the extent of anaerobic energy production during the performance (Brent, 2009).

The energy use in a Swimming race, in a pool, begins with the alactacid system. In a fully and appropriately trained state, the sensitized aerobic system is soon after activated and performs the dual function of providing the means for productive aerobic energy as well as restoring alactacid and lactacid metabolism. Assuming training has been appropriate, type IIb fibers will add to muscle function, in an oxidative manner. During the race, type IIa fibers will generate lactic acid but if it is removed as quickly as it is developed (the "balance" is facilitated by inspired oxygen) at the highest level of concentration that can be tolerated, there will be no degrading or destructive effect from lactate on race performance and/or aerobic function. Only at the very end of a race, is lactacid anaerobic metabolism likely to be elevated for a relatively brief period. When energy is used in the manner and sequence described here, it requires specific training to stimulate the energy sources in race-specific manners. The options for doing that are limited and proposed as being ultra-short training with specific periods of work and rest that cannot be modified. Any training that does not fulfil the criteria for ultra-short training, is a waste of time for serious and elite swimmers; although, paradoxically, it might be beneficial for beginner and young developing swimmers.

The need for oxygen to replenish ATP and remove lactic acid is referred to as the "Oxygen Debt" or "Excess Post-exercise Oxygen Consumption" (EPOC) - the total oxygen consumed after exercise in excess of a pre-exercise baseline level. It can also be termed as anaerobic capacity. In low intensity, primarily aerobic exercise, about one half of the total EPOC takes place within 30 seconds of stopping the exercise and complete recovery can be achieved within several minutes (oxygen uptake returns to the pre-exercise level). Recovery from more strenuous exercise, which is often accompanied by increase in blood lactate and body temperature, may require 24 hours or more before re-establishing the pre-exercise oxygen uptake. The amount of time will depend on the exercise intensity and duration. In the present study, O_2debt is significantly related to 50 meter swimming performance. It is evident that high level of O_2debt helps quick replacement of ATP and lactate removal. In prepubertal age category, no significant differences in O2debt are observed between sports categories (Mandal, 2005). High anaerobic capacity (O_2debt) is an advantage in sprint and power events. So, in the present study, as there was a significant relationship between O_2debt and 50 meter Swimming performance, swimmers having higher O_2debt can perform better.

It has been reported by Shapiro et al, 1967, that recovery heart rate is one of the important parameters for any sportspersons which can influence VO_2max. Verma et al, 1979, observed the relationship between VO_2max and heart rate during work and recovery. Similar finding was also observed in the present study i.e. significant relationship between VO_2max and recovery heart rate. Again, the VO_2max influenced the Swimming performance, which has already been established in the present study. It was found, in the present study, that there was a significant relationship between recovery heart rate and Swimming performance indicating that the swimmers having faster recovery can perform better.

CONCLUSION

Correlation matrix of physiological variables indicated that back strength, grip strength, maximum oxygen consumption, oxygen debt and recovery heart rate are significantly correlated with Swimming performance. From the above findings, it can be concluded that apart from techniques and tactics the physiological attributes play an important role in Swimming performance. Regular monitoring of these variables can help the young swimmers to know their status and the areas to be improved which can help them to achieve excellence in higher level of competition i.e. although the swimmers having similar quality of techniques and skills, but those who are having better physiological qualities can obviously perform better.

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