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AEROBIC AND ANAEROBIC PHYSIOLOGICAL PROFILES IN COLLEGIATE ATHLETES

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ABSTRACT

Recent developments in the physical fitness and training assessments of athletes are premised on the reality that the athlete is confronted with competition-like criteria. Considering physical fitness, it is necessary, because requirements are varied, to examine thoroughly the abilities that have an effect on the development of sports. This paper will aim to describe the physical and physiological comparison of athletes in aerobic and anaerobic evaluation specific to the sports consisting of the individual, team, and combat personalities. The study was carried out with a total of 120 (n=120) players comprised of 40 (n=40) players in each category of individual, team, and combat sports. The recorded data is statistically analyzed using analysis of variance (ANOVA) with a p-value less than 0.05 significant level. Results that are found to be significant are further processed using the Tuckey HSD post hoc test to find the significant difference among the groups. The obtained results show that there is a significant difference between the groups with regards to the VO2 max and lactate threshold.

Keywords: Lactate threshold, VO2 max, Recovery Heart Rate, aerobics, physiological profile.

1. INTRODUCTION

The use of scientific ideas in sports and exercise has grown dramatically over the years. Science's application to sports is particularly obvious in the subject of physiology; in fact, sports professionals are quick to recognize the necessity of learning fundamental physiological information that might yield superior results. For so many decades, exercise physiology has been a respectable discipline in its own right. Exercise has traditionally been used to agitate physiological systems in order to see how they responded to stress. Athletic trainers have also discovered the limits of human physiological reactions as well as the elements that restrict performance in a variety of situations **(Ghosh, 2004).**

Apart from technique, tactics, and skill, physical performance in various competitive sports events is largely dependent on the integrated status of the individual's different physiological mechanisms, i.e. the state of health and capacity for physiological responses to meet the challenges of the competitive situation **(Saltin and Astrand, 1967).** The enhancement of these reactions via training is required for optimal performance. As a result, the primary goal of physiological research is to properly analyze and monitor the training plan. Under optimal circumstances, requirements of sport have a very strong connection with the physical stamina of the athlete that can be classified as 1) Endurance- capacity to carry out the prolonged exercise, 2) exercise at high intensity for prolonged time, 3) sprinting capability, and 4) capacity to generate more output power in a single action. The most essential physiological component for excellent marathon performance is having a high aerobic capacity, often known as VO_2 max. In long-distance endurance events, aerobic metabolism takes precedence, and maximal oxygen uptake (VO_2 max), also known as aerobic capacity, becomes one of the most important deciding variables in elevated performance in sports. VO_2 max refers to a person's cardiorespiratory capability in terms of O_2 intake, distribution, and use **(Åstrand and Saltin, 1961; Conley and Krahenbuhl, 1980; Foster, 1983).** One of the most physiologically relevant and often evaluated metrics in the physiological evaluation of well-trained athletes may be maximum oxygen intake. Another important parameter is the lactate threshold and is created to identify the point at which metabolic acidosis and the resulting alterations in lung gas exchange occur during exercise **(Wasserman et al., 1973).** It means, there is a nonlinear steep increase in ventilation during incremental exercise at a certain intensity, known as the ventilatory anaerobic threshold (Hollman, 1959), a nonlinear increase in blood lactate concentration, known as lactate threshold, a nonlinear increase in CO2 production, an increase in end-tidal oxygen, an increase in CO_2 production, and in arterial lactate level. Numerous researchers with almost the same aim to establish the aerobic and anaerobic transition point, of an exercising human, employ various techniques. Synthesis of lactate in the muscle rises arcuated with escalating workload or even with percentage use of VO2 max.

Another important physiological parameter used to analyze aerobic and anaerobic is the lactate threshold. The Lactate principle is regarded to be a basic value for any physical therapist, along with its basic constructs of lactate metabolism, production, elimination, threshold, and stable state. The aerobic performance of athletes along with clinical research is usually measured using graduated exercise tests. During this stepwise workout, blood lactate is monitored and the workload is traced. The capacity to do the whole-body muscular activity at medium to high frequencies for long periods of time is a significant component of cardiorespiratory fitness evaluated. According to **Pate and Kriska (1984),** maximum oxygen uptake and lactate threshold (LT), as well as oxygen cost of exercise and economy, are assessed for aerobic endurance performance. A person's lactate threshold is defined as the point at which blood lactate levels

abruptly rise as shown in Fig 1. Lactate development or presence in the muscle and its clearance from the muscle are the net results of lactate production or appearance in the muscle, according to several researchers **(Chirtel et al., 1984; Green et al., 1983.** Different sophisticated devices are available in the market to measure blood lactate threshold on the field itself only. In this research, the Conconi test procedure is used to determine the lactate threshold. When performing an exercise, increased sensitivityand decreased vagal release lead to an increase in cardiac velocity, pulse rate, and cardiac output in order to meet the energy requirements of working muscles **(Shephard, 1987)**. Therefore, it is important to know the heart rate and recovery during the activity. The reduction in cardiac beat frequency and the duration of the recovery period following moderate to severe exercise are utilized as aerobic fitness measures **(Chorbajian, 1971).** Therefore, the primary goal of this study is to experiment, measure, and evaluate the physiological parameters such as VO2 max, lactate threshold, and recovery heart rate among the various college-level sports personalities of Dakshina Kannada and Udupi districts by categorizing individual, team, and combat sports. To carry out this experiment standard operating procedures are followed using a treadmill for different tests and readings are recorded.

2. METHODOLOGY

2.1 Design

This study is based on empirical studies, which use cross-sectional and evolutionary studies to evaluate the differences between groups and relations between tests in order to define the performance of an individual, team, and combat sports participants through physical fitness testing.

2.2 Subjects

The study was performed on a total of 120 sports personality volunteers categorizing into Individual Sports Group (ISG) of 40, Team Sports Group (TSG) of 40, and Combat Sports Group (CSG) of 40 each. The subjects were required to given written consent for participation in this Study and the ethical clearance was obtained from the institutional ethical committee. All subjects were instructed to avoid smoking and drinking alcoholic beverages before the experimental procedures and it is ensured that none of the subjects were taking any medication known to influence the findings of the tests. It was also ensured that the subjects had active rest at least 48 hours before the tests.

2.3 Tests

The following tests were conducted to measure the physiological parameters such as Maximal Oxygen Consumption (VO_2 Max), Lactate Threshold and Recovery Heart Rate.

2.3.1 VO_2 max

Beep Test is used to forecast VO_2Max based on a 20-meter shuttle test level and shuttle score. Previous studies show that maximal oxygen uptake values can be predicted from the level attained on a 20m progressive shuttle run test[3]. Based on the VO2Max Score, a fitness rating may be estimated. VO_2 max can be computed by using the regression equation given by **Flouris et al. (2005)**

$$VO_2 \text{ Max} = (\text{Maximal Aerobic Speed} \times 6.65 - 35.8) \times 0.95 + 0.182$$

There are numerous other analytical expressions available in the literature for calculating VO_2Max from shuttle run. There are 21 levels in the beep test. Once the buzzer sound is heard, the person participating in the test must run 20mts. At the next beep he should cross one foot over the line before returning to the starting spot. Similarly he should shuttle back and forth, crossing the 20 mts line at each end at each beep. At beginning of each level the speed increases and the time provided to run each shuttle of 20mts reduces. The fitness score is recorded as the

number of level and shuttle last crossed either at failure or when two consecutive 20 meters are missed by the runner. The mean VO_2 Max of of ISG, TSG and CSG is 52.09, 46.72, and 46.09 ml/kg/min respectively.

2.3.2 Lactate threshold

Determination of lactate threshold is carried out using a motorized treadmill with the gradient set at 1%. At 7 km/h the beginning test speed was set, with increases of 0.5 km/h, up to voluntary fatigue every one minute. The Conconi test procedure is used to determine the lactate threshold.The heart rate is noted on a graph and the point of deflection is taken as the heart rate at which the lactate threshold is reached (Figure1). The lactate threshold rate is expressed as percentage of maximal heart rate. The mean lactate threshold of ISG, TSG and CSG is 90.67, 92.45, and 91.25 respectively.

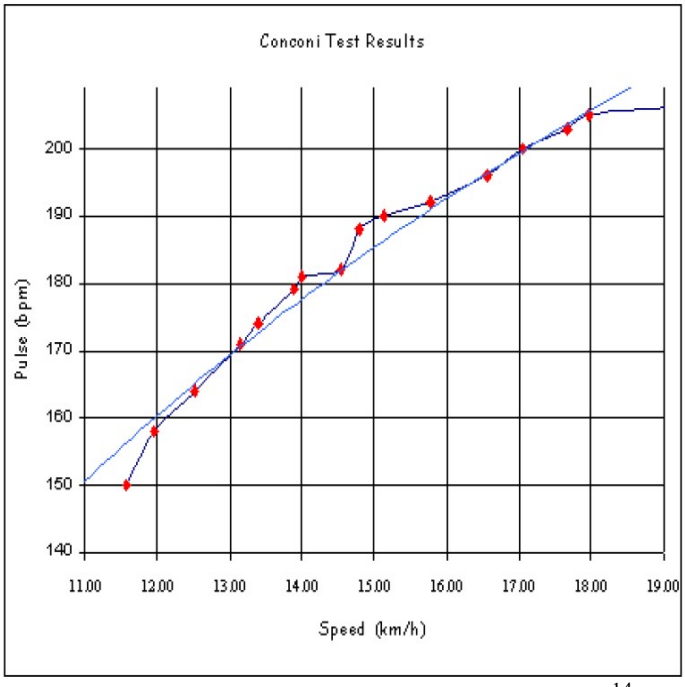

Figure 1. Determination of lactate threshold[14]

2.3.3 Recovery heart rate

Recovery heart rate is recorded soon after the VO_2 Max testing where the subject reaches his maximal heart rate. The participantis made to sit comfortably after the finishing running on the treadmill and his heart rate is recorded at the 1st, 2nd and 3rd minute after completion of the run. The average of the last thirty seconds of each of the minutes is recorded and the average of these three recordings is taken as the Recovery Heart Rate (expressed as percentage of maximal heart rate). The recovery heart rate percentage of ISG, TSG and CSG is 38.89, 40.31, and 40.19 respectively.

3. RESULTS AND DISCUSSION

The demographic data of the subjects are detailed in table 1. The table conveys that all the sportspersons have of similar age and height while understandably the mass of the combat sports group is more. The maximal heart rate is similar as they are of similar age and the BMI does not vary much.

TABLE 1.
DEMOGRAPHIC DATA OF THE GROUPS

Group	Age	Height (cms.)	Weight (kgs.)	BMI (wt. in kgs. /mts. in cms^2	Maximal Heart Rate
Individual Sports Group (ISG)	20.85±1.72	166.45±7.2	57.48±6.53	17.26±1.72	191
Team Sports Group (TSG)	21.03±2.11	170.7±5.75	65.21±7.01	19.11±2.02	191
Combat Sports Group (CSG)	21.28±2.15	171.20±7.28	75.78±13.49	22.10±3.56	191

The analysis of variance (ANOVA) is used to perform statistical analysis for all the tests involved in this study. A confidence level and significant level are set 0.95 and 0.05. Wherever the p-value was found to be less than 0.05 then post hoc analysis was carried out to understand the significant difference between the groups. The following section depicts the interpretation of experimental findings of VO2 max, lactate threshold, and heart rate recovery.

Table 2 exhibits the maximal oxygen consumption, lactate threshold and recovery heart rate of the three groups as derived from the Beep test, Conconi test and the recovery heart rate.

TABLE 2.
MEAN OF DIFFERENT PHYSIOLOGICAL PARAMETERS

Group	VO_2 max	Lactate threshold	Recovery Heart Rate
Individual Sports Group (ISG)	$52.09±2.60^{a}$	$90.67±2.97^{b}$	$38.89±4.60^{a}$
Team Sports Group (TSG)	$46.72±2.86^{b}$	$92.45±3.32^{a}$	$40.31±6.17^{a}$
Combat Sports Group (CSG)	$46.09±2.70^{b}$	$91.25±2.09^{ab}$	$40.19±1.73^{a}$

*Note.*The Values are recorded for 40 subjects in each group, VO_2 max is expressed in ml/kg/min and lactate threshold and recovery heart rate is expressed as percentage of Maximal Heart Rate. The value sharing the same superscript is not significant from each other.

Figure 2 shows the VO_2 max of ISG, TSG and CSG personalities. It can be noticed from the below figure that the participants belonging to the individual events have the highest VO_2 max followed by the participants involved in team and combat sports.

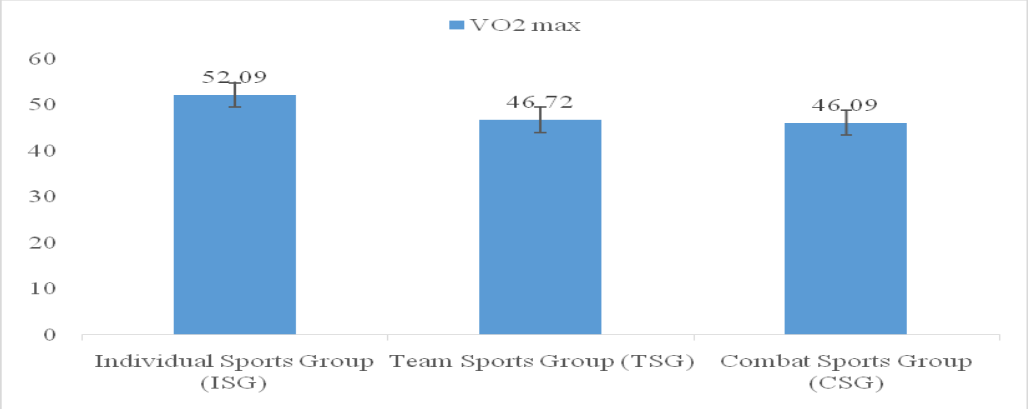

Figure 2. mean and standard deviation of VO_2 max of all categories.

ANOVA test is used to determine the statistically significant difference between the means of the three groups, as indicated in table 3 below.

TABLE 3.
ANOVA RESULT OF VO_2 MAX.

Source of Variation	SS	df	MS	F	P-value	F
Between Groups	870.0556	2	435.0278	58.76959	2.14E-18	3.073763
Within Groups	866.0645	117	7.402261			
Total	1736.12	119				

The significance value associated with the F statistic of the ANOVA result is less than 0.05. This indicates that there is a significant difference between the different sports groups, Individual, Team, and Combat. To categorize which of the pair of the group is significantly different from each other, Tuckey HSD post hoc tests are carried out. It is found that there is a significant difference between the individual and team as well as individual and combat sports groups with a p-value less than 0.01. whereas between team and combat is found to be insignificant.

Figure 3 shows the lactate threshold and recovery heart rate of ISG, TSG and CSG subjects. The mean values of the individual sports, Team sports, and Combat sports are 90.67%, 92.45%, and 91.25%(expressed as percentage of Maximal Heart Rate) respectively for Lactate threshold and 38.89%, 40.31%, and 40.19%(expressed as percentage of Maximal Heart Rate) respectively for Recovery Heart Rate. It can be noticed that participants belonging to team sports has more lactate threshold than the individual and closer value of lactate threshold between the team and combat sports personalities as shown in the below figure.Similarly the recovery heart rate was marginally better for ISG and similar for TSG and CSG.

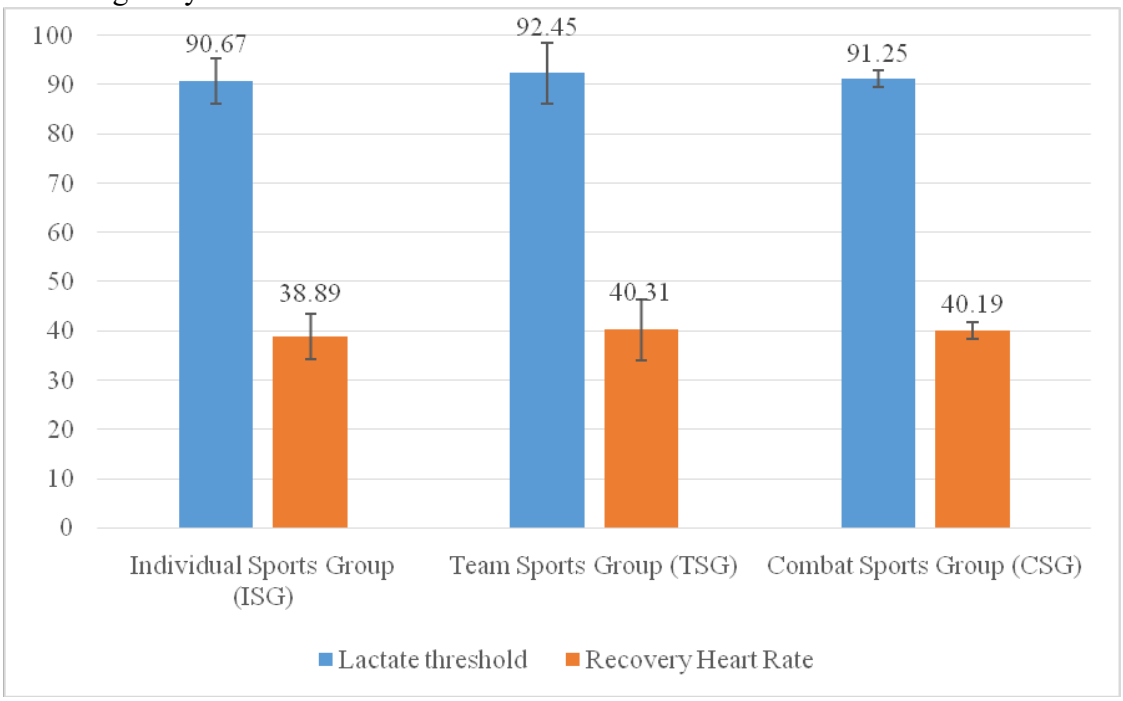

Figure 3. The mean and standard deviation of the heart rate recovery percentage of all groups.

TABLE 4.
ANOVA RESULTS OF LACTATE THRESHOLD

Source of Variation	SS	df	MS	F	P-value	F
Between Groups	65.7203	2	32.86015	4.065422	0.019636	3.073763
Within Groups	945.6921	117	8.082838			
Total	1011.412	119				

The significance value associated with the F statistic of the ANOVA result is less than 0.05. This indicates that there is a significant difference between the different sports groups, Individual, Team, and Combat for lactate threshold. To categorize which of the pair of the group is significantly different from each other, Tuckey HSD post hoc tests are carried out. From the post hoc analysis, it can be stated as there is a significant difference in lactate threshold between the individual and team sports personalities with $p<0.05$. Conversely, there is an insignificant difference in other possible combinations of individual, team, and combat sports.

TABLE 5.
ANOVA RESULTS OF RECOVERY HEART RATE

Source of Variation	SS	df	MS	F	P-value	F
Between Groups	49.67295	2	24.83648	1.198577	0.305299	3.073763
Within Groups	2424.432	117	20.72164			
Total	2474.105	119				

The significance value associated with the F statistic of the ANOVA result is greater than 0.05. This indicates that there is no significant difference between the different sports groups, Individual, Team, and Combat sports.

4. CONCLUSIONS

In the majority of sports, physical demands are complicated and the essential success components for every athlete have to be recognized. Moreover, before a training program can be carried out, the impact of various training kinds must be studied. These modifications in the training program lead to significant muscle adjustments that relate to greater performance. The following concluding remarks can be given with this study.

1. Individual sports participants show better performance in maximum oxygen uptake followed by team sports when compared to combat sports. The individual sports persons comprise of track and field endurance athletes and therefore it can be safely concluded that they would have better oxygen uptake. But the TSG and CSG do not vary significantly.
2. Surprisingly CSG and TSG sportspersons have a better lactate threshold compared to the ISG. The TSG have significantly more lactate threshold from ISG, it does not vary significantly from CSG nor does CSG vary significantly from ISG. This could be because the individual athletes are mostly aerobic runners.
3. There is no significant difference between the three groups in association with the heart rate recovery.
4. This Study throws light on the important physiological profiles of collegiate athletes. It should be noted that the collegiate athletes are not professional athletes and therefore they values would vary on the amount of practice and commitment that they share to achieve excellence. So from this perspective this study could be further progressed to compare the results with the elite counterparts of these groups, and in that context the results would be

more meaningfully interpreted.

5. Further study on elite sportspersons is suggested and would be seen as the next step in interpretation of the results.

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