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An Aerobic Capacity Variable-Based Discriminant Model For The Classification Of Handball Players

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Abstract

Aim of the study - The study aimed to compare the aerobic capacities, specifically the Force Vital Capacity (FVC), Peak Expiratory Flow (PEF), and Maximum Oxygen Consumption (VO2) Max, between male Handball players with high and low performance levels. Additionally, the study sought to establish a criteria for classifying male Handball players into high or low performance groups by utilising discriminant analysis based on the parameters of aerobic capacities.

Material and Methods- A sample of sixty male Handball players who participated in the 2018 Handball Men's Senior National held at Gwalior, Madhya Pradesh India were tested for their aerobic capacities. The data was collected on the last two teams of tournament and top two teams of tournament. Thus, the players were classified into high and low performance groups.

Results- The mean values of all the three aerobic capacities parameters were significantly higher among high performance Handball players in comparison with low performance players. Further, a discriminant model was prepared to classify Handball players into high and low performance groups on the basis of aerobic capacity variables. A disrciminant function Z was developed (Z = –13.21 + 1.20 (FVC) + 0.21 (PEF) + 0.170 (VO2 Max)) The attained discriminant model classified correctly 88.3% of the cases in the sample.

Conclusion- The study clearly demarks the difference present in the aerobic capacities of the different level of players. The result of the study is that the coaches can use aerobic capacity parameters of selecting a elite level basket player and a beginner as well.

Keywords- Aerobic capacities, Handball, Discriminant analysis

INTRODUCTION

The game of Basketball, Handball or Hockey is characterized by frequent starts, stops, and changes of direction, all maintained over a period of time. While a quarter of game play for a high school athlete lasts 8 minutes of clock time, an average segment of play may last only 12–20 s.[1] However, Handball players have been found to cover about 4500–5000 m (2.8–3.1 mi) during a 48–minute game.[2] Also, in a simulated practice game, players were found to spend only 34.1% of the time playing, 56.8% walking, and 9.0% standing.[1] Therefore, both the aerobic and anaerobic metabolic systems are required. When designing training and nutrition programs, it is important to note that the overall physical load, based on heart rate, and oxygen demand are greater for games than scrimmage practice situations.[3] Analyses of physiological requirements of Handball in the past 20 years showed a major reliance on the anaerobic metabolism across positions,[4] with secondary reliance on the aerobic energy system.

Coaches often overlook the contribution of the aerobic energy system for success in Handball; however, aerobic capacity is related to successful performance of high-intensity work over a period of time. For example, a positive correlation was found between Handball-specific repeated sprint ability from game results to maximal oxygen uptake (VO2max), indicating aerobic system maintenance during the last stages of the game.[5] In other studies, VO2max was correlated to the duration of running and jumping during a simulated game[1] and to oxygen uptake and intensity during game play.[6,7] Average VO2max values for male and male Handball players have been reported in the range of 44.0–54.0 and 50–60 mL/kg/min, respectively,[8] although values vary by position, with guards tending to have a higher aerobic capacity than centers.[9] One study suggests that monitoring the heart rate of players during practice is related to VO2max and could help to enhance the quality of practice in establishing and maintaining a level of aerobic fitness.[10]

The relatively high level of aerobic demand, despite the high percent of playing time spent walking and standing, suggests aerobic metabolism is critical in the removal of lactate and the restoration of PCr, which are known to be oxygen-dependent processes[11]. The regeneration of PCr provides the muscle with energy to continue high-intensity contractions. Overall, the intermittent activity pattern in Handball demands aerobic capabilities sufficient to sustain repeated short bouts of high-intensityexercise.[12] The rules of the game, which allow ample substitution and provide rest periods during time-outs, halftime and between quarters, help promote the ability of the aerobic energy system to replenish the anaerobic system for sustained-high intensity efforts.

Aim of the study

In games like Hockey, Football, Basketball and Handball a great amount of aerobic capacity is required for good performance; a limited concern is given by coaches to develop aerobic endurance in parallel to developing anaerobic capacities more often. The purpose of the study was to compare the aerobic capacities i.e. FVC,PIF and VO_2 Max between the high and low performance male Handball players and to develop a criteria for classifying male Handball players into high or low performance groups by using discriminant analysis on the basis of aerobic capacities parameters.

Material and Methods

A sample of sixty male Handball players who participated in the 2018 Handball Men's Senior National held at Gwalior, Madhya Pradesh India were tested for their aerobic capacities. The data was collected on the last two teams of tournament and top two teams of tournament. Thus, the players were classified into high and low performance groups.

Forced vital capacity (FVC) were measured in liters, Peak expiratory flow (PEF) were measured in liters per second. FVC and PEF were measured through digital spirometer. VO_2 Max (Maximum Oxygen Consumption) was measured with the help of 12 minutes Copper run walk test. Distance completed by the subject was recorded in kilometers and for calculating VO_2max the following equation was used. VO2max = (22.351 x kilometers) - 11.288.[13]

Results

The data was analyzed by using discriminant analysis for developing discriminant function for classifying individuals into high and low performance groups. Analyses were carried out with the use of SPSS software package (ver. 20.0). The results so obtained are discussed in this section.

Table I. Means (± SD) for data on aerobic capacity parameters of elite Handball players

VARIABLES	HIGH PERFORMING	LOW PERFORMING	MEAN DIFFERENCE
FORCE VITAL CAPACITY	4.43 ±0.56	3.446 ±0.60	0.99
PEAK EXPIRATORY FLOW	4.07 ±0.68	3.16 ±0.681	0.91
VO_2 Max	53.25 ±2.76	50.06 ±5.08	3.19

Table I shows the comparison of mean values between high and low performance groups in all three aerobic capacities parameters. There was a significant difference between high performance and low performance groups in aerobic capacities parameters i.e., FVC, PIF and VO_2. Furthermore, it may be concluded that the mean scores of the three aerobic capacities parameters were significantly higher in the high performance group than in the low performance group. Thus, it may be interpreted that the aerobic endurance was very high among the high performing basket ball players. This is true also because much of the success in the game depends upon the efficiency of lungs. The data was further analyzed by using discriminant analysis and the obtained results are shown in Tables II to VI. The unstandardized discriminant coefficients are shown in Table II.

Table 2 – Un-standardized discriminant coefficients

VARIABLES	FUNCTION
FORCE VITAL CAPACITY	1.200
PEAK EXPIRATORY FLOW	0.21
VO_2 Max	0.170

These coefficients were used to develop the discriminant function. The resulting discriminant model included all three variables because all of them were found to have a significant discriminant power. Thus, the discriminant function developed by using these discriminant coefficients was as follows:

Z = –13.21 + 1.20 (FVC) + 0.21 (PEF) + 0.170 (VO2 Max)--------1

Table -3 Wilk's Lambda distribution

Test of function(s)	1
Wilk's lambda	0.425
Chi-square	48.291
df	3
Sig.	0.00

The value of Wilks' lambda distribution as shown in Table III is 0.425 and therefore the discriminant model can be considered to be good enough for developing a discriminant function. The value of Wilks' lambda falls between 0 and 1. A lesser Wilks' lambda value indicates the robustness, whereas its higher value indicates the weakness of the model. Since the value of chi-square in Table III is significant (p = 0.00), it may be inferred that the discrimination criterion between the two groups is highly significant.

Table-4 Classification matrix

Levels of performance		Predicted group membership		
		High Performance	Low Performance	Total
Original count	High	28	2	30
	Low	5	25	30
%	High	93.3	6.7	100.0
	Low	16.7	83.3	100.0

88.3% of original grouped cases correctly classified.

Table IV is a classification matrix which provides the summary of correct and incorrect classification of subjects in both groups by the discriminant model. It can be seen that the percentage of correct classification amounted to 88.3%, which is fairly good and therefore it may be concluded that the

discriminant model is efficient. Table V shows the relative strength of the variables selected in the discriminant model on the basis of their discriminating power. The variable with a higher coefficient is more powerful in discriminating between the two groups. Since the coefficient of VO2 Max is 0.67, i.e. maximum, therefore the discriminant power of this variable is maximum as well. On the other hand, the coefficient of PEF was 0.021, which shows that this variable had the least discriminant power among the three variables. The purpose of this study was to obtain a decision model for classifying male Handball players into high or low performance groups. This can be done by using the discriminant function (Z) developed in the equation (1) above.

Table V. Standardized canonical discriminant function coefficients

Variables	Function
FORCE VITAL CAPACITY	0.704
PEAK EXPIRATORY FLOW	0.014
VO_2 Max	.677

Table VI. Functions at group centroids

Levels of performance	Function
Low	-1.143
High	1.143

Table VI gives the new means for the transformed group's centroid. Thus, the new mean for Group 1 (low performance Handball players) is –1.143 and for Group 2 (high performance Handball players) is +1.143. This indicates that the mid-point is zero. These two means can be plotted on a straight line by locating the mid-points as shown in Figure 1. Figure 1 gives the criteria for classifying any new subject. If the discriminant score of any male Handball player lies on the right side of the midpoint i.e., $Z > 0$, he may be classified into the high performance group, whereas if it lies on the left side of the midpoint i.e. $Z < 0$, he may be classified into the low performance group.

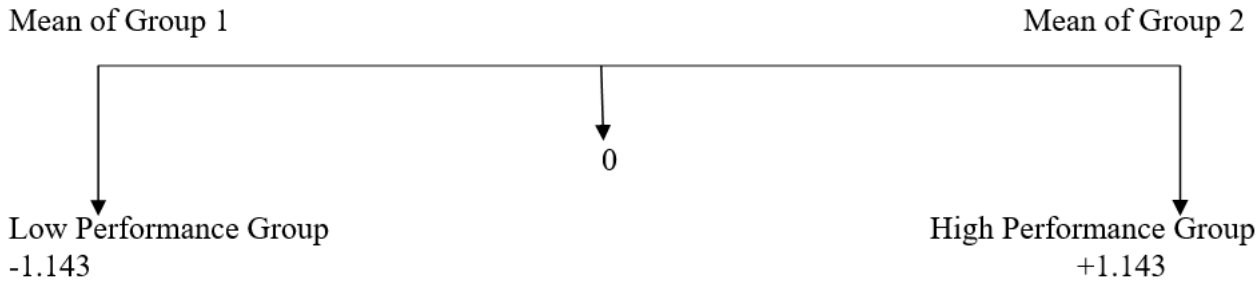

Figure 1 :- Means of the transformed group centroids

Discussion

The study wanted to answer three research questions. The first question was whether the aerobic capacities parameters differ significantly between high and low performance male Handball players. Secondly, we were interested to know as to whether it is possible to develop a robust discriminant model on the basis of aerobic capacities parameters. Thirdly, whether the model so developed can be effectively used for classification in future.

Since high and low performance groups differ in all three aerobic capacity parameters the first question was well answered. The results of the finding are in line with findings of Piiper J, Bishop, D [11,12]

Since the percentage of correct classification of cases was 88.3% hence the developed model can be considered effective. This answers the second research question. Since the discriminant model in this study is developed on the basis of a small sample thus the level of accuracy shown in the classification matrix may not hold for all future classifications of new cases, therefore one should take caution in using this model. In order to obtain more accurate findings it is suggested that such future research studies may be undertaken on larger samples.

The outcomes of the study suggest the coaches and fitness trainers must work on the lung efficiencies of the players from very basic levels. Team games are becoming fast day by day which requires anaerobic metabolism at peak but basic lungs endurance should be developed in parallel as aerobic endurance is key of improving anerobic capacities and for matching the pace of the game.

Conclusion

This study clearly demarks the difference present in the aerobic capacities of the different level of players. The result of the study is that the coaches can use aerobic capacity parameters of selecting a elite level basket player and a beginner as well.

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