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Development of Discriminant Model for Classifying Throwers on the Basis of Anthropometric and Physical Fitness Variables

Upendra Patidar[1] and Dr. Vikas Saxena[2]

[1]PhD Scholar, Department of Physical Education, Rabindranath Tagore University, Bhopal (M.P.), INDIA

[2]HOD, Department of Physical Education, Ravindra Nath Tagore University, Bhopal (M.P.), INDIA

[1]Corresponding Author: u.patidar01@gmail.com

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ABSTRACT

The purpose of this study was to develop a discriminate model to classify throwers (discus, javelin and hammer) on the basis of anthropometric variables and to predict their group membership based on the developed model. There were 25 discus throwers, 25 hammer throwers and 25 javelin throwers of age group 17-25 selected as subjects. The data were collected on anthropometric variables i.e. height, weight, sitting height, (leg, arm, hand) length, shoulder width, (chest, hip, thigh, calf) circumference, (back, shoulder, grip and leg explosive) strength. The anthropometric variables were measured by using selected standardized instruments and measuring tapes. Data collected was analyzed at 0.05 level of significance, descriptive statistics and multiple discriminant analysis was applied to classify and predict group membership of the throwers into the discus, hammer and javelin. The results showed that 68.0% of original grouped cases were correctly classified and 45.3% of cross-validated grouped cases correctly classified.

Keywords- Throwers, Discus, Javelin, Hammer, Anthopometric.

I. INTRODUCTION

The performance achievements of Olympic athletes come from a unique combination of inherited traits and capacities developed through training. Identifying factors such as physical size and structure, which may result in the best performance, can assist the exercise scientist and coach in selecting and developing talented athletes (Ackland 2005).

Specific anthropometric characteristics are needed to be successful in certain sporting events, although, expert opinions often differ when it comes to this matter. There are number of papers dealing with anthropometrics and body type of athletes in various sports (Heath & Carter, 1967), as well as different playing positions in a specific sport (Matković et al., 2003, Jeličić et al, 2002). Rare, but very interesting are studies on the influence of morphological characteristics on top sport achievements, as the research carried out on javelin throwers (Čoh and co., 2002).

The throwers (Discus, Javelin, and Hammer) are field events in athletics. They are measure for explosive strength (power) in a human being from ancient time to modem time. The throwers of shot put, Discus, Javelin and hammer differed greatly in physique from the other athletes. As a group, they are taller and heavier, with longer arms in relation to their legs. They had broader shoulders aid broader hips even for their trunk size, and were somewhat fatter than the track athletes. Their proportions of legs to the trunk were similar to those of middle distance runners.

Despite the fact that many physical, psychological and physiological factors contribute to successful performance in athletics, there are a lack of comprehensive study conducted about athletes from Madhya Pradesh and this paper is intended to fill some gaps in these regards.

In modern sports, the anthropometric measurements and their relationship with various physical fitness traits are an important guide for the coaches and athletes themselves for making training

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schedules and for classification of players into different groups according to their ability. The development, maturity status, functional capacities and skills of athletes have received reasonable attention in the literature.

II. METHODOLOGY

A sample of total 75 throwers was selected through purposive sampling technique. These throwers were further subdivided into twenty five [N= 25] throwers for each three categories (discus, hammer and javelin). The data was collected on the following eleven anthropometric variables - height, weight, sitting height, (leg, arm, hand) length, shoulder width, (chest, hip, thigh, calf) circumference. All the anthropometric measurements were measured to the $1/10^{th}$ of the centimetre. Non-stretchable measuring tape was used to measure the length. Stadiometer was used as a tool for measuring the height of the subjects.

III. RESULTS

The data was analyzed by using discriminant analysis for developing discriminant function for classifying the throwers into discus, hammer and javelin group.

Table 1: Descriptive statistics of anthropometric and physical fitness variables.

	Discus Throwers		Hammer Throwers		Javelin Throwers	
VARIABLES	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Height	175.56	4.700	177.48	5.277	178.20	5.244
Weight	73.32	10.621	83.16	4.578	76.88	12.457
Sitting Height	104.84	4.758	106.40	4.735	106.24	4.236
Arm Length	77.28	2.776	78.32	7.059	77.16	2.953
Leg Length	100.24	2.554	101.16	4.134	100.32	2.897
Hand Length	18.64	0.550	18.58	0.795	18.54	0.611
Shoulder Width	42.10	1.147	42.34	1.193	41.90	.901
Chest Circumference	95.76	5.981	101.88	3.127	99.04	6.717
Hip Circumference	101.40	7.794	101.18	1.574	100.08	6.976
Thigh Circumference	55.36	2.515	56.04	1.780	55.80	1.979
Calf Circumference	37.20	1.658	37.36	1.791	37.96	1.172
Back Strength	92.48	4.293	84.00	7.339	89.80	5.923
Shoulder Strength	9.418	.6400	9.302	0.706	9.345	.566
Grip Strength	124.56	3.525	108.2	124.76	124.28	3.646
Leg Explosive Strength	2.268	.231	2.364	2.343	2.315	.218

Table 1 shows the descriptive statistics of anthropometric variables and physical fitness variables of discus throwers, hammer throwers and javelin throwers. The data was further analyzed by using discriminate analysis and the obtained results are shown in Table 1 to 6.

Table 2: Un-Standardized Discriminant Coefficients

Canonical Discriminant Function Coefficients		
	Fun. 1	**Fun. 2**
Height	0.087	.056
Weight	0.020	-.028
Sitting Height	- .119	.123
Arm Length	- 0.028	-.103
Leg Length*	- 0.016	.037

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Hand Length	- 0.679	-.338
Shoulder Width	- 0.426	-.700
Chest Circumference	0.101	.066
Hip Circumference	-.049	-.020
Thigh Circumference*	0.007	.042
Calf Circumference	0.269	.189
Back Strength	-.108	.082
Shoulder Strength*	0.010	-.162
Grip Strength	0.039	-.058
Legs Explosive Strength	1.194	-.408
(Constant)	- 13.131	7.599

These coefficients were used to develop the discriminant function. The resulting discriminant model included all variables except Leg length, Thigh Circumference and Shoulder Strength as their coefficient value is too small. Thus, the discriminant function 1 developed by using these discriminant coefficients was as follows:

$$= -13.131 + (.087 \times X_1) + (-.020 \times X_2) + (-.119 \times X_3) + (-.028 \times X_4) + (-.679 \times X_5) + (-.426 \times X_6) + (.101 \times X_7) + (-.049 \times X_8) + (.269 \times X_9) + (-.108 \times X_{10}) + (.039 \times X_{11}) + (1.194 \times X_{12})$$

Table 3: Wilks' ambda Distribution

Wilk's Lambda				
Test of Function	**Walk's Lambda**	**Chi-Square**	**df**	**Sig.**
1	0.429	55.016	30	.000
2	0.813	13.487	14	.489

The value of Wilks' lambda distribution as shown in Table 3 is 0.429 and 0.813 for function 1 and function 2 respectively. The value of Wilks' lambda falls between 0 and 1. A lesser Wilk's lambda value indicates the robustness, whereas its higher value indicates the weakness of the model. Therefore, the discriminant model developed for function 1 can be considered to be good enough for developing a discriminant function. However, the the function 2 developed is not significant as the p-value for the function is 0.489.

Table 4: Classification Matrix

Classification Results[a,c]						
Status			Predictive Group Membership			Total
			Hammer	Discus	Javelin	
Original	Count	Hammer	15	2	8	25
		Discus	1	19	5	25

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		Javelin	4	4	17	25
	%	Hammer	60.0	8.0	32.0	100.0
		Discus	4.0	76.0	20.0	100.0
		Javelin	16.0	16.0	68.0	100.0
Cross-validated[b]	Count	Hammer	12	3	10	25
		Discus	4	14	7	25
		Javelin	10	7	8	25
	%	Hammer	48.0	12.0	40.0	100.0
		Discus	16.0	56.0	28.0	100.0
		Javelin	40.0	28.0	32.0	100.0

a. 68.0% of original grouped cases correctly classified.
b. Cross validation is done only for those cases in the analysis. In cross validation, each case is classified by the functions derived from all cases other than that case.
c. 45.3% of cross-validated grouped cases correctly classified.

Table 4 is a classification matrix which provides the summary of correct and incorrect classifications of subjects in both groups by the discriminant model. It can be seen that the percentage of correct classification amounted to 68%, which is fairly good and therefore it may be concluded that discriminant model is efficient.

Table 5: Standarized Canonical Discriminant Function Coefficients

	Fun 1	**Fun 2**
Height	0.284	.288
Weight	0.008	-.318
Sitting Height	- 1.01	.630
Arm Length	- 0.006	-.304
Leg Length	- 0.029	.123
Hand Length	- 0.416	-.202
Shoulder Width	- 0.138	-.860
Chest Circumference	0.025	.466
Hip Circumference	0.014	-.150
Thigh Circumference	0.026	.091
Calf Circumference	0.171	.285
Back Strength	0.007	.538
Shoulder Strength	0.890	-.126

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Grip Strength	0.095	-.212
Legs Explosive Strength	- 0.758	-.092

Table 5 shows that 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 wilks' lambda of function 2 is insignificant, only coefficient of function 1 had been taken consideration. The coefficient value of sitting height is 1.01, i.e. maximum, therefore the discriminant power of this variable is maximum as well. On the other hand, the coefficient of arm length was 0.006, which shows that this variable had the least discriminant power among the fifteen variables.

The purpose of this study was to obtain a decision model for classifying the throwers into discuss, Javelin and Hammer throw group. This can be done by using the discriminant function (Z) developed in the equations (1)

Table 6: Funtions at Group Centroids

Status	**Function**	
	1	2
Hammer thrower	.949	-.459
Discuss thrower	-1.257	-.188
Javelin thrower	.308	.647

Table 6 gives the new means for the transformed group's centroid. Thus, the mean for Group 1 (discus) is -1.257, mean for group 2 (javelin) is 0.308 and mean for group 3 (hammer) is 0.949. This indicates that the two mid-points among three groups are -0.474 and 0.628. These two means can be plotted on a straight line by locating the mid-points as shown in Figure 1. This figure 1 gives the criteria for classifying any new subject. If the discriminant score of any throwers lies on the left side of the midpoint i.e. Z < -0.474, he may be classified into the Discus throw, whereas if it lies on the right side of the midpoint i.e. Z > -0.474, the thrower may be classified into the Javelin group. Similarly if the discriminant score of any thrower lies on the left side of the midpoint 0.628 i.e. Z < 0.628, he may be classified into the javelin thrower and if it lies on the right side of the midpoint i.e. Z > 0.628, he may be classified into the hammer group.

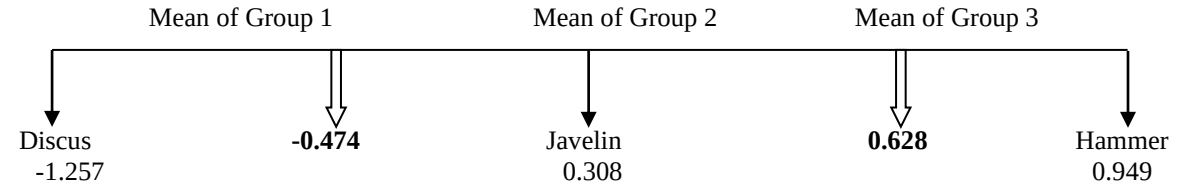

Figure1: Means of the Transformed Group Centroids

IV. DISCUSSION OF FINDINGS

The study wanted to answer mainly two research questions. The first question was whether, it is possible to develop a robust discriminant model on the basis of physical fitness and anthropometric variables. Secondly, whether the model so developed can be effectively used for classification in future. Since the percentage of correct classification of cases was 68% hence the developed model can be considered effective. This answers the first research question. Since the discriminant model showed 45.3% of cross-validated grouped cases classified correctly. It means that the probability of the model is 45.3% to correctly classify the new group of throwers based on the selected anthropometric and physical fitness variables. Thus, the level of accuracy shown in the classification matrix may no hold for all future classifications of new cases, therefore on 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 physical fitness variables as well as take anthropometric variables in to consideration from very basic levels because the throwers of Discus, Javelin and hammer differed greatly in physique from the other athletes. As a group, they are taller and heavier, with longer arms in relation to their legs. They had broader shoulders and broader hips even for their trunk size, and are somewhat fatter than the track athletes. Their proportions of leg to the trunk are similar to those of track athletes.

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V. CONCLUSION

This study clearly demarks the difference present in the physical fitness and anthropometric variables of discus, javelin and hammer throwers. The result indicates that the disciminant model can correctly nearly 70% of the group. Therefore, the coaches can use the selected anthropometric and physical fitness variables to predict their group membership that is discus, javelin and hammer throwers.

Conflict of Interest

Authors declare no conflict of interest

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