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Formulation of discriminant model for classifying an individual into ball badminton and badminton

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Abstract
The purpose of the study was to identify anthropometric variables that discriminate among groups of male athletes; from two sports (Ball Badminton, n = 26; aged 20.35±1.32 years; Badminton, n = 33; aged 19.52±1.75 years) into Ball Badminton and badminton sport. There were fifty nine athletes aged 19.88±1.62 years; selected from the Gwalior district for the study. The participants for the study had been involved in their relevant game for 2–3 years. The anthropometric variables included physique, body mass, arm flexed and tensed (arm girth), forearm girth, wrist girth, thigh girth, calf girth, arm length, forearm length, hand length, thigh length, and leg length. In order to bring about the aim of the study, a discriminant analysis method was employed. Discriminant functions revealed two significant functions ($p<0.05$) i.e. wrist girth and thigh length, which mainly showed differences between Ball Badminton and badminton. A discriminant function Z was developed (Z = 0.91 ─ 0.98 × (Wrist Girth) + 0.29 × (Thigh Length)). After validation, the examination showed that 76.3% of the athletes were accurately classified in their relevant games.

Keywords: Male, racket game, anthropometry, multivariate analysis

Introduction
Anthropometric aspects assume a significant part in deciding the outcome of a competitor (Reco-Sanz, 1998; Keogh 1999; Wilmore and Costill, 1999) [6, 13]. Zawawi, (2012) [14] brought up that anthropometric estimations rely upon computing the measures of outer body structures (heights, widths, and circumferences). Wearing achievement rely upon contingent and coordinative capacity, for example, abilities, specialized strategy capacity, individual capacities, actual qualities and wellbeing factors (Ozbar, 2002) [10]. Anthropometric estimations can be separated into height, weight and lengths, breadth or width, circumferences or girths, depths and skinfolds. The exploration on anthropometric estimations might be helpful in choosing the appropriate game or game for any person. Anthropometric estimations of an individual are significant resource for a few games, and along these lines, considered among the primary models for outcome in many games (Bompa, 1999) [3]. Body measurements and actual body creation are significant elements that influence actual execution. That was additionally guaranteed by Al-Bisati, (1998) who refers to the presence of high connection between the actual capacities and anthropometric estimations for all presentation levels of various game exercises. In this way, it is vital to consider the body structure and actual necessities while choosing competitors for each game (Brahim *et al*., 2013) [2]. For this reason, the job of anthropometric estimations in any game is generally significant.
Badminton is a games branch which can be played effectively by all individuals from a few ages (Memedov and Kale, 1994) [9]. Then again ball badminton isn't just a games branch which is so famous. Ball badminton is a rivalry initially from India. It is a racket game played on a court isolated by a net with a yellow ball made of fabric. National Ball-Badminton Association of India was set up in the year 1954. Beginning around, 1970, the Ball-Badminton match-up was played in each University of India. Ball Badminton is a very much like racquet game to tennis. As per Groppel and Roetert, (1992) [5]; the actual necessities of racket sports request effectiveness in various wellness parts. Along these lines we see that size; shape and type of the players are known to assume a huge part in the exhibition of ball badminton and badminton players. There are not many examinations directed on ball badminton so the after-effects of the current review will supply helpful

information to ball badminton mentors about the significance of the anthropometric qualities. Essential Skills of ball badminton and badminton like servicing, lifts and smashing, requires a particular kind of build having explicit extents with specific contingent capacities. The presentation of these components relies upon many elements including the anthropometric attributes. The aim of this study was to create a discriminant model and to foresee the probability that a specific element will have a place with a specific game (ball badminton / badminton) based on the selected independent variables.

Methods

Participants & Measures

Fifty nine male athletes aged 19.88±1.62 years were selected in the study as a participant from Gwalior district. The sample covered two different sports: ball badminton, n = 26, aged 20.35±1.32 years (mean ± s); badminton, n = 33, aged 19.52±1.75 years (mean ± s). The athletes competed over a season of at least 12 months in their respective sport.

All participants were assessed on the following anthropometric parameters: stature (height), body mass (weight), arm flexed and tensed (arm girth), forearm girth, wrist girth, thigh girth, calf girth, arm length, forearm length, hand length, thigh length, and leg length. Weight was measured by digital standing scales to the nearest 0.1 kg. The readings were recorded from the scales of the digital weighing machine and the height was recorded during inspiration using a stadiometer to the nearest 0.1 cm. Others anthropometric measurements were recorded in centimeters (to the nearest 0.1 cm).

Statistical analysis

Descriptive statistics was employed to know the Mean and Std. Deviation in all anthropometric parameters and Discriminant analysis was then applied to the anthropometric parameters, to formulation a model capable of predicting which of the two different sports the athletes participated in. The statistical analyses were performed using the SPSS software package; significance was set at $P<0.05$.

Results

The data was analyzed by using discriminant analysis for developing discriminant function for classifying an individual into Ball Badminton and Badminton on the basis of selected anthropometric parameters. The results so obtained are discussed in this section.

Table 1: Mean and Std. Deviation of Selected Anthropometric Variables of Ball Badminton and Badminton Players

Variables	Ball Badminton		Badminton	
	Mean	Std. Deviation	Mean	Std. Deviation
Height (Cms)	169.03	6.92	169.58	5.71
Weight (Kgs)	59.22	5.42	58.95	5.58
Arm flexed and tensed (Cms)	28.69	1.45	28.88	1.92
Forearm girth (Cms)	24.80	1.56	25.05	1.30
Wrist girth (Cms)	16.07	0.74	15.51	0.65
Thigh girth (Cms)	49.54	3.07	51.12	2.92
Calf girth (Cms)	33.11	1.67	33.83	1.25
Arm length (Cms)	30.25	2.19	30.98	1.58
Forearm length (Cms)	25.59	1.72	25.79	1.22
Hand length (Cms)	19.09	1.30	19.04	0.81
Thigh length (Cms)	48.93	2.87	52.00	2.91
Leg length (Cms)	37.88	1.98	38.08	1.88

Table 1 showed that the mean of Ball Badminton in Weight, Wrist girth and Hand length was higher than the badminton whereas the Height, Arm flexed and tensed Forearm girth, Thigh girth, Calf girth, Arm length, Forearm length, Thigh length and Leg length was higher in badminton than the Ball Badminton group, respectively.

The data was further analyzed by using discriminant analysis and the obtained results are shown in Tables 2 to 6.

Table 2: Unstandardized Canonical Discriminant Function Coefficients

	Function
Wrist girth	-0.98
Thigh length	0.29
(Constant)	0.91

The unstandardized discriminant coefficients are shown in Table 2. These coefficients were used to develop the discriminant function. The resulting discriminant model included two variables were found to have a significant discriminant power. Thus, the discriminant function developed by using these discriminant coefficients was as follows:

$$Z = 0.91 - 0.98 \times (\text{Wrist Girth}) + 0.29 \times (\text{Thigh Length})$$

Equation 1

Table 3: Wilks' Lambda and Chi Square of the Model

Test of Function(s)	Wilks' Lambda	Chi-square	df	P value
1	0.66	23.53	2.00	0.00

In Table 3 the value of wilks lambda is 0.66, which shows that 66% of the variability is not explained by the wrist girth and thigh length to the Ball Badminton and badminton sport in the discriminant model. This point towards that approximately 34% of the variation in the two groups is explained by the discriminant model. Therefore the discriminant model can be considered to be moderately good adequate for developing a discriminant function. Since the value of chi-square in Table 3 is found to be significant at 2 df i.e. calculated chi square 23.53 is greater than tabulated chi square 5.99 at 0.05 level of significance, it may be inferred that the discriminant model is highly significant.

Table 4: Classification Matrix of Predicted Group Membership

Classification Results					
Ball Badminton	**Badminton**	**Sport**	**Predicted Group Membership**		**Total**
Original Count %		Ball Badminton	22.00	4.00	26.00
		Badminton	10.00	23.00	33.00
		Ball Badminton	84.62	15.38	100.00
		Badminton	30.30	69.70	100.00
76.3% of original grouped cases correctly classified.					

Table 4 is a classification matrix which shows the summary of correct and wrong classification of subjects in both the groups based on the discriminant model. It can be seen that out of the 26 subjects belonging to the Ball Badminton category, 4 were not correctly classified in the same category, whereas out of 33 subjects in the Badminton category, 10 were not classified in the same category. Thus out of fifty-nine cases, the model correctly classified 45 cases (76.3%). It can be seen that the percentage of correct classification amounted to 76.3%, which is fairly good and therefore it may be concluded that the discriminant model is efficient.

Table 5: Standardized Canonical Discriminant Function Coefficients

	Function
Wrist girth	─ 0.68
Thigh length	0.83

Table 5 shows the relative strength of the variables selected in the discriminant model on the basis of their discriminating power. Since the coefficient of wrist girth is ─ 0.68, which shows that this variable had the least discriminant power among the variables as well. On the other hand, the coefficient of thigh length was 0.83; therefore the discriminant power of this variable is maximum.

Table 6: Functions at Group Centroids

Sport	**Function**
Ball Badminton	-0.80
Badminton	0.63
Unstandardized canonical discriminant functions evaluated at group means	

The purpose of this study was to attain a decision model for classifying an individual into any of the two sports, i.e. Ball Badminton and Badminton. This can be done by using the discriminant function (Z) developed in the *Equation 1* above. Table 6 gives the new means for the transformed group's centroids. Thus, the new mean for sport 1 (Ball Badminton Players) is -0.80 and for sport 2 (Badminton) is 0.63. This indicates that the mid-point is zero. If the discriminant score of any male individual lies on the right side of the midpoint i.e., $Z > 0$, he may be classified into the Badminton sport, whereas if it lies on the left side of the midpoint i.e. $Z < 0$, he may be classified into the Ball Badminton sport. These two means can be plotted on a straight line by locating the mid-points as shown in Figure 1.

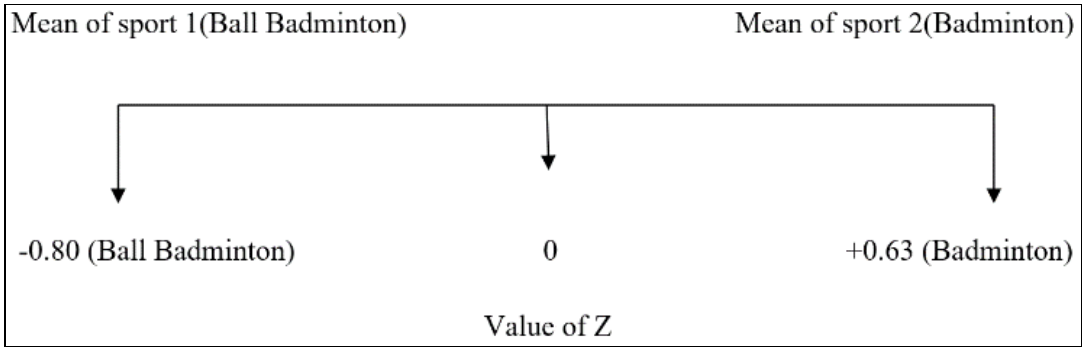

Fig 1: Means of the transformed group centroids

Discussion

The study intended to know the response whether it is feasible to create a strong discriminant model based on anthropometric boundaries. Since ball badminton and badminton sports differ in two anthropometric parameters. Additionally, the expansion in thigh's length and the player's whole length raise the circle's half border which would prompt speeding up, and afterward increment the legs' development speed that would contribute really to keeping up with and building up balance (Kostic *et al*., 2009) [8]. Racket sports are viewed as a profoundly unstable action (Singh *et al*., 2011) in light of the fact that it involves particular development abilities like bouncing, jumping, and different arm strokes (Shariff *et al*., 2009) [12]. The study of Goswami and Yadav, (2015) [4]; uncover that the wrist circumference has seriously separating power and more the wrist bigness increments, whole strength likewise increment of the racket players and furthermore normal anthropometrical attributes to be expected for the players. Therefore, the muscles' resilience increments also and that straightforwardly add to expanding the capacity to keep up with balance. The leg's solidarity relies upon the strength of foots' and thighs' muscles. As a rule, they are the vitally working muscles in the developments of foot joint while moving this way and that while playing tennis, and they offer players the opportunity of moving while at the same time keeping up with balance and the move's critical similarity (Jyoti *et al*., 2012) [7]. Since the level of right characterization of cases was 76.3% henceforth the created model can be viewed as successful and shows the significance of anthropometric factors between ball badminton and badminton. Along these lines, with this

discriminating model an individual can be easily discriminated to both the sports. The discriminant score of the model was Z = 0.91 ─ 0.98 × (Wrist Girth) + 0.29 × (Thigh Length) with the group centroids (ball badminton = -0.80 and badminton= +0.63). Since the discriminant model in this study is created based on a little example along these lines the degree of precision displayed in the characterization framework may not hold for all future arrangements of new cases, subsequently one ought to take alert in utilizing this model.

Conclusions

The results in the study could act as an aide for mentors as well as scientists searching for a reference model for separating both the games explored. As far as anyone is concerned, not many endeavors have been made to distinguish the factors that separate the middle of the road individual into ball badminton and badminton. In this way, there is a reasonable requirement for additional examination to cross-approve the discoveries from the current concentrate on an alternate and larger sample.

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