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Discriminant Analysis of Performance Categories Among National-Level Rifle Shooters: Identifying Key Differentiators Between High and Low Performers

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Abstract

Aims: The aim of the study was to focus on differentiating performance levels among national-level rifle shooters using discriminant analysis.

Method: Thirty national-level male rifle shooting players from India were selected as the subjects for the study. For the study physical and motor (static balance, balance, shoulder strength), physiological (breath holding capacity, heart rate, respiratory rate), anthropometric (height, weight, arm length, leg length, shoulder width), psychological (trait and state anxiety, locus of control, stress), foot morphological (length of foot, width of foot, heel width, heel girth) and shooting performance (score of players 60 rounds = 654) variables were used for the study. Quartile deviation was used to make the level of performance (Low & High).

Results: The shooting performance data was categorized into two groups: Low Performance and High Performance based on quartile deviation. It was found that high and average performers exhibited greater shoulder strength (30) compared to low performers (26.37), while static balance (bass stick test crosswise) and balance (stork standing balance test) were notably higher in the high-performance group than in the low-performance groups. Variable like respiratory rate, STAI-1 anxiety, length of foot, heel width, heel girth was more or less similar

Conclusion: The regression equation suggests that higher static balance scores, wider shoulders, and a higher locus of control are positively associated with better performance levels. Conversely, higher stress scores, wider feet, and wider heels are negatively associated with performance levels.

Keywords: Discriminant Analysis, Performance Category, Rifle Shooting, Players

Introduction

Rifle shooting is a sport that involves extreme precision, focus, and control. A variety of elements can influence performance in this sport, including physical and motor abilities, anthropometric physiological,

psychological, foot morphology, and performance traits, as well as practices and environmental conditions. Understanding these elements and distinguishing between high- and low-performing athletes is critical for coaches, trainers, and sports scientists looking to improve training programs and overall performance.

The sport of rifle shooting requires a high level of focus, accuracy, and consistency. Because of the competitive nature of the sport, players are always looking for ways to improve. Many elements affect rifle shooting performance, such as technical proficiency, psychological mood, physical conditioning, and even ambient circumstances (Laaksonen et al., 2011).

Sports scientists have long employed discriminant analysis to categorize athletes according to their performance and pinpoint the crucial elements that set one degree of accomplishment apart from another. Using this method, people can be categorized into preset categories by creating a discriminant function based on a collection of predictor variables (Meyers et al., 2013). Discriminant analysis's strength is its capacity to manage several variables at once, offering a thorough understanding of the variables affecting performance.

Prior study on rifle shooting has emphasized the importance of a variety of physical, psychological, and technical skills. (Mononen et al. 2007), for example, found that eye-hand synchronization, response time, and mental toughness are all important for excellent success in shooting sports. Similarly, (Konttinen and Landers 1999) stressed the importance of appropriate arousal and attention in distinguishing great shooters from less successful competitors.

The goal of this study was to use discriminant analysis to determine the essential characteristics that distinguish high performance shooters from low performance shooters on a national scale. The study hopes to provide significant data that may be used to adapt practices and improve the performance of rifle shooting players. Understanding these distinct elements is not only academically interesting, but also practical in terms of developing tailored interventions to improve rifle shooters' performance.

Methodology

Thirty national-level male rifle shooting players from India were selected as the subjects for the study. For the study physical and motor (static balance, balance, shoulder strength), physiological (breath holding capacity, heart rate, respiratory rate), anthropometric (height, weight, arm length, leg length, shoulder width), psychological (trait and state anxiety, locus of control, stress), foot morphological (length of foot, width of foot, heel width, heel girth) and shooting performance (score of players 60 rounds = 654) variables were used for the study. Quartile deviation to make the level of performance (Low & High) and Discriminant Analysis was used for the present study.

Results: The shooting performance data was categorized into two groups: Low Performance and High Performance based on quartile deviation. These quartile values provide insights into the distribution of shooting performance scores, helping to categorize performances into different levels based on their quartile positions. The analysis categorized players into high (10 players) and low (8 players) performance groups based on quartile deviation.

Results

Table- 1 showed that the quartile deviation of performance score of the players (N=18)

Percentile	Score

25	627.375
50	629.600
75	630.625

The shooting performance data was categorized into two groups: Low Performance and High Performance based on quartile deviation. The quartile values were calculated as follows:
- Q1 (25th percentile): 627.60 , Q2 (50th percentile, median): 628.30 and Q3 (75th percentile): 629.85. These quartile values provide insights into the distribution of shooting performance scores, helping to categorize performances into different levels based on their quartile positions. The analysis categorized players into high (10 players) and low (8 players) performance groups based on quartile deviation.

Table- 2 showed that the Tests of Equality of Group Means

	Wilks' Lambda	F	df1	df2	Sig.
Static balance (Bass Stick Test (sec))	.584	11.401	1	16	.004
Shoulder Width (cm)	.787	4.318	1	16	.050
Locus of control	.749	5.363	1	16	.034
stress score	.634	9.218	1	16	.008
Width of foot (cm)	.556	12.790	1	16	.003
heel width(cm)	.725	6.077	1	16	.025

Table no.- 3 showed that the Group Statistics

Performance Level)		**Mean**	**Std. Deviation**
High	Static balance (Bass Stick Test (sec))	72.7500	18.41553
	Shoulder Width (cm)	43.0600	2.96880
	Locus of control	11.8000	2.97396
	stress score	33.5000	1.17851
	Width of foot (cm)	8.6660	.42792
	heel width(cm)	5.0200	.37653
Low	Static balance (Bass Stick Test (sec))	50.1075	4.55929
	Shoulder Width (cm)	40.2400	2.71634
	Locus of control	8.2500	3.53553
	stress score	37.1250	3.56320
	Width of foot (cm)	9.4250	.47132
	heel width(cm)	5.5000	.45040

The data table reveals several distinctions between high and low performance levels in the context of static balance and associated physical and psychological characteristics. High performers exhibit significantly better static balance, as indicated by a mean Bass Stick Test duration of 72.7500 seconds, compared to

50.1075 seconds for low performers. This superior balance is accompanied by a larger standard deviation, suggesting greater variability among high performers. Additionally, high performers tend to have wider shoulders (mean of 43.0600 cm) compared to low performers (mean of 40.2400 cm). They also exhibit a higher locus of control (mean of 11.8000) versus 8.2500 for low performers, indicating a stronger belief in their ability to influence outcomes. Stress levels are lower among high performers, with a mean stress score of 33.5000 compared to 37.1250 for low performers, suggesting that lower stress may contribute to better performance. Moreover, high performers have narrower foot and heel widths (mean foot width of 8.6660 cm and heel width of 5.0200 cm) compared to low performers (mean foot width of 9.4250 cm and heel width of 5.5000 cm). These physical characteristics likely enhance their balance and stability. The data suggest that a combination of physical attributes and psychological factors, such as a wider shoulder width, higher locus of control, lower stress levels, and narrower feet and heels in high performers.

Table-4 showed that the Summary of Canonical Discriminant Functions

Eigenvalues				
Function	Eigenvalue	% of Variance	Cumulative %	Canonical Correlation
1	2.198[a]	100.0	100.0	.829

Table- 5 showed that the Wilks' Lambda

Test of Function(s)	Wilks' Lambda	Chi-square	df	Sig.
1	.313	15.111	6	.019

Table-6 showed that the Canonical Discriminant Function Coefficients

	Function
	1
Static balance (Bass Stick Test (sec))	.027
Shoulder Width (cm)	.163
Locus of control	.105
stress score	-.137
Width of foot (cm)	-.791
heel width(cm)	-.552
(Constant)	5.213

Table 4 reveals that the Eigenvalues was greater than 1 and the canonical correlation was .829 which shows that 67% of variation in the level of performance was because of the static balance (Bass stick test), shoulder width (cm), locus of control, stress, width of foot (cm) and heel width (cm) . In table 5 Wilks' Lambda indicated that the most influential variable in performance classification p=.019 .

Thus based on the table 6 the performance level can be predicted as follows

Performance level= 5.213 + .027 (static balance) Bass Stick test in sec) + .163 (shoulder width in cm) +.105 (Locus of control) -.137(stress)-.791(width of foot in cm)-.552(heel width in cm)

Discussion

Balance is very important for rifle shooting because correct balance stabilizes the body and stability has the greatest impact on correct rifle shooting performance. Therefore, balance is most important for rifle

shooting. Shoulder width is therefore very important for rifle shooting because the broader the shoulder, the more support the rifle will get, which will result in better performance in rifle shooting. In the locus of control, the person who controls the internal locus will be responsible for this. This means that he is a focus and has the ability to do his work himself and to do it right. He has control over all the things that bring change in his life and in shooting, locus of control is very important so that you do not rely on luck but work hard yourself and set all the situations right. Stress is important for rifle shooting because if the stress is high then it will have a greater effect on rifle shooting performance because in this stress the shooter's focus and patience decreases and the mind gets distracted which makes it difficult to concentrate on the performance. Therefore, stress affects the shooter's performance. The wider the foot width the greater the base area which will give more balance to the body, making rifle shooting and performance even better. The heel width is important in rifle shooting because while shooting the weight of the body goes on the heel. Therefore, the more the heel width the heel, the more support the base will get, which will result in better shooting performance. The regression equation suggests that higher static balance scores, wider shoulders, and a higher locus of control are positively associated with better performance levels. Conversely, higher stress scores, wider feet, and wider heels are negatively associated with performance levels. These relationships highlight the importance of physical attributes and psychological factors in determining performance levels

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