Physique–Physiology Interactions: A Multivariate Analysis of Body Composition and Functional Capacity in Elite Indian Para-Athletes

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Abstract

Background: The physiological efficiency of Para-athletes is influenced by body composition, which varies according to the demands of different sports disciplines. This study aimed to examine the multivariate interactions between body composition and functional physiological variables among elite Indian Para-athletes, focusing on event-specific distinctions across track, field, and jumping events.

Methods: A total of 30 male Para-athletes (mean age = 24.6 ± 3.2 years) were purposively selected and divided equally into three groups: track (n = 10), field (n = 10), and jumping (n = 10). The body composition metrics assessed included total body fat as a percentage, muscle mass measured in kilograms, bone mass also measured in kilograms, subcutaneous fat as a percentage, and visceral fat as a percentage. The physiological variables measured were systolic blood pressure (mmHg), pulse rate (bpm), resting heart rate (bpm), and vital capacity (L). Descriptive statistics were calculated, followed by usingMultivariate Analysis of Variance (MANOVA) to evaluate group differences and employ Pearson's correlation to explore relationships between variables.

Results: MANOVA indicated a statistically significant multivariate impact of the event category on the set of dependent variables. (Wilks' Lambda = 0.412, $F(18, 40) = 2.62$, $p = 0.005$, partial $\eta^2 = 0.54$). Univariate ANOVAs revealed notable differences in vital capacity ($F(2,27) = 4.35$, $p = 0.022$,$\eta^2 = 0.24$), muscle mass ($F(2,27) = 3.97$, $p = 0.029$, $\eta^2 = 0.23$), and subcutaneous fat ($F(2,27) = 3.58$, $p = 0.041$, $\eta^2 = 0.21$) among the groups. Track athletes displayed the highest vital capacity (mean = 3.1 L) and muscle mass (mean = 32 kg), along with the lowest subcutaneous fat (mean = 12%) compared with the field and jumping groups. Pearson's correlation analysis revealed a positive relationship between muscle mass and vital capacity ($r = 0.457$, $p = 0.010$), while it showed negative relationships with pulse rate ($r = -0.403$, $p = 0.023$) and systolic blood pressure ($r = -0.354$, $p = 0.045$). Furthermore, both total body fat and visceral fat were found to have positive correlations with resting heart rate ($r = 0.377$ and $r = 0.342$, respectively; $p < 0.05$) and negatively correlated with vital capacity.

Conclusion: This study highlights the significant physique–physiology interactions in elite Indian para-athletes. Greater muscle mass and lower adiposity are associated with enhanced pulmonary capacity and reduced cardiovascular load. These findings support the implementation of event-specific conditioning programs focused on optimizing body composition to enhance functional capacity and performance outcomes in parasports.

Keywords

Para-athletes, Body Composition, Physiological Function, Muscle Mass, Vital Capacity, Cardiovascular Efficiency, MANOVA.