TACSM Abstract

Comprehensive Analysis of Mental Toughness Predictors Using Machine Learning Techniques

OLIVIA RUSSELL[1], TOMAS CHAPMAN-LOPEZ[1], RICARDO TORRES[1], MEENA MEIYYAPPAN[1], LEROY BOLDEN[1], KIMBERLY SMITH[1], ANDREAS STAMATIS[2], AND JEFFREY S. FORSSE[1]

[1] Integrated Laboratory of Exercise, Nutrition, and Renal Vascular Research, Department of Health, Human Performance, and Recreation, Baylor University; Waco, TX; [2] Sports Medicine; University of Louisville Health; Louisville, KY

Category: Undergraduate

Advisor / Mentor: Forsse, Jeff (Jeff_Forsse@Baylor.edu)

ABSTRACT

Mental toughness (MT) is a critical determinant of success in various high-pressure environments. Traditional methods of assessing MT often rely on subjective metrics only (self-assessed questionnaire scores), which may lack the precision and objectivity necessary for a thorough understanding. **PURPOSE**: To develop an objective, quantitatively robust model to predict MT, by integrating physiological and psychological variables using machine learning (ML) techniques. **METHODS**: The study involved a sample of 50 participants, encompassing diverse demographic backgrounds and physiological (e.g., DEXA, complete metabolic and lipid panel, and complete blood count) and psychological (e.g., Mental Toughness and Self-compassion surveys) characteristics. The analysis began with descriptive statistics to understand the dataset's structure, followed by handling missing values through imputation methods. Key variables identified included self-compassion (SC), white blood cell count (WBC), total protein, Android/Gynoid Ratio, and Trunk/Leg Fat Ratio. Principal Component Analysis (PCA) was employed for dimensionality reduction, ensuring the model's efficiency, and addressing multicollinearity. A Random Forest Regression model was chosen for its ability to handle complex, non-linear relationships. The model underwent iterative tuning, adjusting parameters like the number of trees (300), tree depth (no limit), and minimum samples for node splitting (2) and leaf nodes (1). The process also included evaluating and comparing linear and non-linear approaches, cross-validation for robustness, and detailed performance metrics analysis. **RESULTS**: The final model (R2 = 0.74) indicates a high degree of variance explanation in MT scores. Key predictive factors included both physiological measures and psychological aspects, along with body fat distribution metrics. The Mean Squared Error was 0.29, reflecting the model's accuracy and precision in prediction. **CONCLUSION**: This study illustrates the effective use of ML in integrating diverse physiological and psychological factors to predict MT with high accuracy. The findings provide a nuanced understanding of MT, suggesting that it is influenced by a complex interplay of mental and physiological health aspects. This model serves as a valuable tool for identifying key factors in MT, aiding in targeted interventions for performance enhancement and resilience training.