

Development and Comparison of Heart Rate-Based Energy Expenditure Prediction Models During Taekwondo Poomsae

Jihwan Park, Dae Taek Lee

Exercise Physiology Laboratory, Kookmin University, Seoul, Republic of Korea

ABSTRACT

Purpose: This study aimed to develop energy expenditure (EE) prediction models using heart rate (HR) and physical characteristics during Taekwondo poomsae and to compare their explanatory power and predictive accuracy.

Methods: Fourteen male collegiate Taekwondo poomsae athletes each performed eight recognized poomsae, yielding 112 trials. HR and EE were measured using a heart rate monitor (H10; Polar, Finland) and a respiratory gas analyzer (K5; Cosmed, Italy), respectively. Height, body mass, and body composition were also measured. Based on these data, five linear regression models were developed using mean HR alone (Model 1) or mean HR combined separately with body mass (Model 2), fat-free mass (Model 3), fat mass (Model 4), or body mass index (Model 5). Regression analyses were performed using IBM SPSS Statistics 28.0. Model fit was assessed using the coefficient of determination (R^2), while predictive accuracy was evaluated using leave-one-subject-out cross-validation (LOSO-CV) implemented in Python 3 within SPSS. Mean absolute error (MAE) and root mean squared error (RMSE) were calculated to assess prediction errors.

Results: R^2 values for Models 1~5 were 0.134, 0.368, 0.403, 0.143, and 0.233, respectively. Corresponding LOSO-CV MAEs were 1.296, 1.171, 1.131, 1.429, and 1.317 kcal/min, while RMSEs were 1.598, 1.441, 1.390, 1.751, and 1.600 kcal/min. Model 3, which combined mean HR and fat-free mass, showed the highest R^2 and lowest prediction errors among the five models. Compared with Model 1, Model 3 reduced MAE by approximately 12.7% and RMSE by 13.0%.

Conclusion: Combining fat-free mass with mean HR resulted in lower EE prediction errors than using HR alone during Taekwondo poomsae. These findings suggest that fat-free mass may be useful for HR-based EE estimation. However, further validation in an independent sample of athletes is needed.

Keywords: *Taekwondo, Poomsae, Heart Rate, Energy Expenditure, Prediction Model*