Mathematical Models Of Torque-Velocity Relation

Gergana Koroleova[1], Nevena Pencheva[2], Peter Milanov[1,3], Stefan Stefanov[1]

[1] Faculty of Mathematics and Natural Sciences, South-West University "Neofit Rilski", Blagoevgrad

[2]Faculty of Public Health, Health Cares and Sports, South-West University "Neofitt Rilski", Blagoevgrad

[3] Institute of Mathematics and Informatics, Bulgarian Academy of Sciences, Sofia

koroleova@swu.bg, nevena_pencheva@yahoo.com, peter_milanov77@yahoo.com, stefm@swu.bg

Keywords:torque-velocity relation, polynomials, cubic spline, Boltzmann function

The modeling of torque-velocity relationship in various joints and different muscle groups is analyzed in the literature mainly with polynomial functions. The purpose of this study was to compare the mathematical models with polynomial, cubic spline and Boltzmann function. The torque (Nm) was measured at 10 untrained women with isokinetic dynamometer for flexors and extensors of the elbow of the following range of velocities 30-210 ^{o}/s. There was no statistically significant differences in the values of peak torque between flexors and extensors at all velocities (Kruskal-Wallis ANOVA, $p< 0.05$). However, there differences in the values of the torque, more pronounced of the high velocities were established (Kruskal-Wallis ANOVA). The comparative analysis of mathematical models fitted with a polynomial of 4th order, proved the optimal in our previous study, with a cubic spline and with a Boltzmann function, of torque-velocity relation revealed: (1) Although the modeling with cubic spline, the interpolation curve passes through all points unlike with polynomial curve at 4th order, the curves at both models show nonphysiological behavior especially at flexors in the range 180-210 ^{o}/s. and (2) The curves obtained by modeling of the relationship with Boltzmann function, were as close as possible to the classical force-velocity relation of Hill (Proc. R. Soc. Lond., 1938, 126 (843)) for a single mascle. Further studies are needed to determine how much exponential functions, which are less studied, are optimal for the modeling of such relationships.