NONLINEAR ANALYSIS OF THE PHYSIOLOGY AND BIOMECHANICS OF KICKING IN THAI BOXING

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The force exerted by a kick on an impact surface is determined by a set of variables that include the angle of the resultant force produced by the foot at the moment of impact and the instantaneous acceleration of the foot, both relative to the surface being kicked. Our objectives were to: a) determine the height at which the boxer kicks with maximum force, from video data; b) find the correlation between technique deterioration and heart rate response to repeated kicking with the same leg and technique to exhaustion; c) compare the difference between the two legs. Our study can be a very useful tool to identify weaknesses that are to be addressed via training.

With institutional ethics approval, 2 male participants aged 15 and 16 performed a series of kicks used in Thai boxing. The first experiment involved a series of 6 round house kicks at 5 different heights (1.80m, 1.50m, 1.20m, 0.90m, 0.60m) ranging from the maximum possible to the minimum at which the pads could safely be held. The second experiment involved measuring the heart rate beat to beat during a 3 min round of repeated round house kicks to exhaustion of a pad held at a constant height. Each experiment was performed from rest first with the right foot and then following a recovery of 20 mins secondly with the left.

Two stationary Canon MV700i and MV730i video cameras placed orthogonally to the athletes, filming at a rate of 25 fps and with a shutter speed of 1/2000s were used. The video recordings were analysed using Quintic Biomechanics 9.03. A Polar Vantage NV heart rate monitor was used. Editing of the raw heart rate data was performed to exclude the deviations due to missed R waves, misread T waves, or spurious peak waves [2,3]. The heart rate data oscillates around a smooth curve called the basic response pattern obtained using a Fourier curve smoothing method [2,3].

Balance whilst kicking was analyzed using an adaptation of the model in [1]. The height of maximum kicking force was determined by calculating the height of the greatest foot acceleration. Modern numerical techniques were used to calculate the acceleration of the foot over the duration of the kick, allowing us to observe the acceleration pattern and hence minimize the error in the predicted acceleration at the point of impact.

Our study showed that during a bout of kicking to exhaustion there was a nonlinear correlation between the kicking frequency and the heart rate. Fatigue caused a nonlinear decrease in the freely determined kicking frequency which was found to be surprisingly simple mathematically.

References

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