原　著

ローラースキー滑走時の機械的効率が競技成績に与える影響

Effects of mechanical efficiency in roller skiing on racing performance

中井　聖[1)]　　伊藤　章[2)]

Akira Nakai[1)]　　Akira Ito[2)]

Abstract

The aims of the present study were to determine mechanical efficiency based on work done on body segments during roller skiing with a diagonal stride at various speeds and to examine the effects of mechanical efficiency on racing performance in roller skiing. Nine male collegiate cross-country ski athletes with different levels of roller ski racing performance volunteered to participate in this study. Two dimensional kinematics and oxygen uptake were determined in the athletes who performed roller skiing at the five paced speeds of 1.67, 2.50, 3.33, 4.16 and 5.00 $m \cdot s^{-1}$ using the diagonal stride on a 400-m level track. Mechanical efficiency in this study was evaluated with net efficiency, which was calculated from total mechanical work rate comprising the rates of internal and external work and net energy expenditure rate. Rates of total mechanical work and net energy expenditure and net efficiency at race speed were estimated from individual regression equations and mean race speeds of the athletes. Total mechanical work rate had a strong linear correlation with roller skiing speed (r = 0.987, $p < 0.001$) but had no correlation with racing performance at all given speeds. Net energy expenditure rate at the speeds of 1.67, 2.50, 3.33 $m \cdot s^{-1}$ negatively correlated with racing performance (r = -0.821, $p < 0.01$; r = -0.794, $p < 0.05$; r = -0.733, $p < 0.05$, respectively). Estimated total mechanical work rate and net efficiency at race speed directly correlated with racing performance (r = 0.743, $p < 0.05$; r = 0.771, $p < 0.05$, respectively). The ratio of net efficiency at race speed to maximum net efficiency was 98.1 ± 2.8%. These results indicated that equivalent total mechanical work rate is needed to exert the same speed regardless of the athletes' racing performance and patterns of motion in roller skiing, that higher mechanical efficiency enhances racing performance and mechanical efficiency can be a determinant of racing performance and that the athletes in the race would subconsciously select individual speeds to perform roller skiing at maximum efficiency. Thus, these findings suggested that the high-level athletes would have more developed musculature to transform the same level of aerobic energy to higher mechanical work and exert higher speed than the low-level athletes.

キーワード　ダイアゴナルストライド，内的仕事，外的仕事，net efficiency
diagonal stride, internal work, external work，net efficiency

[1)] 大阪体育大学大学院スポーツ科学研究科　*Graduate School of Sport and Exercise Science, Osaka University of Health and Sport Sciences*

[2)] 大阪体育大学体育学部　*School of Health and Sport Sciences, Osaka University of Health and Sport Sciences*