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A NEW DEVICE TO ESTIMATE VO2 DURING CYCLING ON INCLINES BY ACCELEROMETRY AND BAROMETRY

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Purpose: Recently, cycling exercise has been highlighted for health promotion for across young to older generations; however, there have been few devices to estimate energy expenditure during cycling in the field including inclines. We have already developed the calorimeter (JD-Mate, Kissei Comtec, Matsumoto) to estimate energy expenditure (VO2, ml/kg/min) during walking on inclines from the equation of VO2 = aVM + bHu + cHd, where VM (G) is a vector norm of 3 dimensional accelerations measured with a tri-axial accelerometer, and Hu and Hd (m/min) are uphill and downhill speeds, respectively, measured with a barometer. Based on these results, in the present study, we newly determined the values of a, b, and c in order to estimate energy expenditure during cycling on inclines.

Methods: First, we had 5 male and 2 female adults (28-57 yr) perform cycling trials on the level ground at the speeds of 5, 10, 15, 25 km/h for 5 min during which period we measured VM with the above calorimeter and VO2 with a portable respiratory gas analyzer (Metamax 3B, Cortex, Leipzig) and determined the value of a. Second, we had 8 male and 1 female adults (25-57 yr) performed 2 cycling trials at subjective slow and fast speeds on the incline; 1150m horizontal distance and 62m altitude distance, by the protocol of 5-min rest at the highest altitude, downhill cycling to the lowest altitude, 5-min rest at the lowest altitude, and uphill cycling to the highest altitude in that order, and then, we determined the values of b and c from VM and VO2 measured during the trials. Finally, to validate the precision of the equation, we had 5 male and 2 female adults (28-57yr) perform cycling on the outdoor course composed of level, uphill, and downhill roads; 2,500m horizontal distance and 15m altitude distance, and the compared VO2 estimated from the equation and VO2 measured with the respiratory gas analyzer during the trial.

Results: The values that we determined are a = 0.129 ± 0.027 (mean ± SE, ml/kg/G), b=1.534 ± 0.357 (ml/kg/min (m/min)), and c= 0.311 ± 0.097 (ml/kg/min (m/min)). The eVO2 estimated by the equation; eVO2 = 0.129 VM + 1.534 Hu + 0.311 Hd, was highly correlated with mVO2 measured with the respiratory gas analyzer (r = 0.923, P<0.0001) with a regression equation of eVO2 = 0.994 mVO2 with a mean difference of 0.17 ± 4.36 (mean ± SD) over the range of 0.0 - 25.9 ml/kg/min.
VO₂ by Bland-Altman analysis.

**Conclusions:** We have successfully determined the equation to estimate VO₂ precisely during cycling exercise on outdoor roads including inclines using the calorimeter.

**Key words:** cycling exercise, inclines, outdoor, calorimeter, VO₂ estimation