CHANGE IN THE ENERGETICS OF MIDDLE DISTANCE RUNNERS DURING RACE

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INTRODUCTION
In middle distance running, it is important that not only to run in fast speed but also to maintain the speed as long as possible, by effectively using the mechanical energy exerted. The purpose of this study was to investigate changes in mechanical energy and its use for middle distance runner during official race, and to obtain findings on middle distance running techniques.

METHODS
One hundred and thirteen male 800m runners (height 1.75 ± 0.05 m; body mass 62.8 ± 4.63 kg; race record 1'45"99 to 1'58"61) of various performance levels in official races were videotaped by video cameras (60 Hz) at 350m, 550m and 750m marks of the 800m race. The two dimensional coordinates of the runner’s body were obtained by digitizing VTR images, and were smoothed with a Butterworth low-pass digital filter.

Instantaneous total mechanical energy of (E_i) of the i th segment at time t was calculated by the following equation:

\[ E_{i,t} = m_i g h_{i,t} + \frac{1}{2} m_i V_{i,t}^2 + \frac{1}{2} I_i \omega_{i,t}^2 \]  

(1)

where, \( m_i \) = segment mass; \( g \) = acceleration of gravity (9.81 m/s²); \( h_{i,t} \) = height of segment center of mass; \( V_{i,t} \) = translational velocity; \( I_i \) = moment of inertia about the segment center of mass; and \( \omega_{i,t} \) = the angular velocity for segment i. Mechanical work By assuming the transfer of energy both within and between segments, mechanical work (W_{ab}) was calculated by equation (2) (Pierrynowski et al., 1980):

\[ W_{ab} = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} (\Delta E_{i,j}) \]  

(2)

where \( n \) = number of frame. The amount of mechanical energy transfer within the body (T_b) was calculated by equation (3) (Pierrynowski et al., 1980):

\[ W_b = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} (\Delta E_{i,j}) \]  

\[ T_b = W_b - W_{ab} \]  

(3)

Mean power (MPWR) was calculated by dividing the mechanical work by a cycle time. The effectiveness index of mechanical energy utilization to running velocity (EI) was calculated by equation (4) (Ae and Fuji, 1996):

\[ EI = \frac{\frac{1}{2} M V^2}{W_{ab}} \]  

(4)

The relationships between performance descriptors and mechanical energy variables were tested by Pearson correlation coefficient. The level of statistical significance was set at 5%.

RESULTS AND DISCUSSION
The running velocity (RV) at each mark and mean running velocity of 800m race were significantly related to at all marks. RV was also significantly related to the stride length / height (SL/H) at all marks (Figure 1a). There was significant relationship between RV and stride frequency at 750m mark, but no significant relationships at 350m and 550m mark. These results suggest that, 800m runners should maintain their large stride length during race and emphasize stride frequency in the end stage of the race.

RV and MPWR was significantly related at only 350m mark (r=0.224, p<0.05) (Figure 1c). RV and EI was significantly related at 550m (r=0.259, p<0.01) and 750m mark (r=0.276, p<0.01) (Figure 1d). These results indicate that, the importance of mean power and effectiveness of energy use changed in the course of 800m race so that the mean power output plays a greater role in the first half and the effective use of energy becomes more important in the second half of the race.

RV and Tb were significantly related at all marks (Figure 1b). Tb and SL/H, EI presented significant relationships at all marks. Some investigations reveal that excellent runner transfer greater mechanical energy between the right and left legs than other runners. 800m runners will be able to increase the stride length and EI by improving the amount of mechanical energy transfer between the body segments.

REFERENCES

Figure 1 Relationships of RV to a) SL/H, b) Tb, c) MPWR and d) EI for all runners at each mark.