INVERSE RELATIONSHIP BETWEEN $\text{VO}_{2\text{max}}$ AND ECONOMY IN WORLD-CLASS CYCLISTS

Dear Editor-in-Chief:

Atkinson et al. (1) question whether the correlation between $\text{VO}_{2\text{max}}$ and cycling “economy” may be spurious (3). We would suggest another established explanation why this relationship is biologically based, predictable, and certainly not spurious in athletes whose competitive abilities are relatively similar (6, p. 49–50).

Already in 1988, we (5) noticed that the peak speed they achieved during a maximal treadmill test (Fig. 10 in reference 5) was the best predictor of running performance in a heterogeneous group of athletes. A more extensive data set (7) confirmed that the peak treadmill running speed was the best predictor of running performance at distances from 10 to 90 km, a conclusion repeatedly confirmed (2,4,8). The data of Lucia et al. (3) also support the interpretation that the peak work rate during maximum exercise testing has specific significance.

Their data show that the individual cyclist’s maximum work rate (W·kg$^{-1}$) was unrelated to either the $\text{VO}_{2\text{max}}$ ($P = 0.07; r^2 = 0.32$) or cycling economy ($P = 0.47; r^2 = 0.06$) in contrast to the significant relationships between $\text{VO}_{2\text{max}}$ and cycling economy (Figs. 2–4 in reference 5). However, when individual data for submaximal and maximal $\text{VO}_{2}$ in their three athletes with similar peak work rates of 7.3–7.4 W·kg$^{-1}$ (their athletes 1, 3, and 10) are plotted (Fig. 1), it is clear that differences in cycling economy explain why, at essentially the same peak work rate, the least economical cyclist (athlete 1) has the highest $\text{VO}_{2\text{max}}$ of 82.5 mL·kg$^{-1}$·min$^{-1}$, whereas the most economical cyclist (athlete 10) has the lowest $\text{VO}_{2\text{max}}$ of 65.5 mL·kg$^{-1}$·min$^{-1}$. The cyclist with the intermediate economy (athlete 3) also has the intermediate $\text{VO}_{2\text{max}}$ of 73.3 mL·kg$^{-1}$·min$^{-1}$. Furthermore, the least economical athlete in the trial (athlete 4) has the second highest $\text{VO}_{2\text{max}}$ (82.3 mL·kg$^{-1}$·min$^{-1}$), but he also achieved the highest peak work rate (7.7 W·kg$^{-1}$).

These data show that the $\text{VO}_{2\text{max}}$ and exercise economy cannot be independent predictors of performance since they are intimately related in each individual (Fig. 1). Athletes with superior ability will achieve high peak work rates (relative to body weight in cyclists but not in runners) during progressive exercise; the $\text{VO}_{2\text{max}}$ each achieves will then depend on his or her economy. Yet, since it is the peak work rate that is the more important predictor of athletic ability, their performances will be more similar despite quite different values for $\text{VO}_{2\text{max}}$ and cycling economy. Thus, in groups of subject homogeneous for exercise performance (and hence for peak work rate), $\text{VO}_{2\text{max}}$ and economy will always be inversely related as found by Lucia et al. (3).

The general reluctance to accept this logical explanation is because it conflicts with the universal preconception that the oxygen consumption determines the exercise performance (6) so that those athletes with the greatest capacity to consume oxygen must be the best athletes. The opposite interpretation is that the high $\text{VO}_{2\text{max}}$ of elite athletes is the consequence and not the cause of their superior athletic ability (6).

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