

The 4th dimension: physiological resilience as a determinant of endurance performance

The physiological determinants of distance running performance are widely accepted to be the maximal oxygen uptake (VO₂max), the lactate threshold (LT), and running economy (RE). These three variables can be measured during an incremental treadmill test in the laboratory and used to predict race performances. However, it is rarely acknowledged that VO₂max, LT and RE are not static but rather are *dynamic* variables that change with time as fatigue develops during endurance exercise. Studies show, for example, that RE deteriorates and the critical speed (the highest speed that can be sustained in a steady-state) falls during 2 hours of heavy exercise. This has given rise to the notion of a '4th dimension' in the physiology of distance running, namely, fatigue resistance or *resilience*. There is substantial inter-individual variability in the magnitude of resilience – and yet its physiological determinants are obscure. Moreover, the interaction between fatigue development, biomechanical alterations and changes in O₂ cost are under-explored such that 'causes' and 'consequences' are unknown. This lecture will explore this concept and consider whether the 'all-time greats' of marathon running, including Paula Radcliffe and Eliud Kipchoge, achieve their greatness at least in part as a consequence of superior resilience. The lecture will also consider whether training, footwear or nutritional interventions might influence resilience and therefore enhance performance.