Supplementary Appendix

This appendix has been provided by the authors to give readers additional information about their work.

Supplement to: Robinson AT, Watso JC, Babcock MC, Joyner MJ, Farquhar WB. Record-breaking performance in a 70-year-old marathoner. N Engl J Med 2019;380:1485-6. DOI: 10.1056/NEJMc1900771

Supplementary Material

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Methods

Approvals and Screening

This protocol was approved by the University of Delaware IRB. Oral and written consent were obtained. We measured resting blood pressure, heart rate and rhythm (12-lead electrocardiogram), height, and weight. We obtained a venous blood sample following an overnight fast to assess liver and kidney function, lipid profile, complete blood count, and glucose.

Running Economy and Maximal Oxygen Consumption (VO_{2max}) Test

In preparation for performance testing, the participant was advised to maintain habitual race day fluid/meal consumption and refrain from vigorous exercise for ≥24 hours. Testing took place in September 2018. The athlete performed RE testing and a maximal treadmill running test to volitional exhaustion. Oxygen uptake was measured and averaged in 15-second intervals using indirect calorimetry via an automated open circuit system (Parvo Medics, Sandy, UT). Before the test, the gas analyzers were calibrated with standardized gases (16%O_2, 4.05% CO_2) and the pneumotach was calibrated using a standard volume of air (3L). Heart rate was monitored via a polar heart rate (HR) monitor.

RE represents the energy demand for a given velocity of submaximal running, and is determined by measuring the steady-state consumption of oxygen at each velocity. Less energy demand for given velocity indicates a runner is more economical and exerting themselves to a lesser extent, which is beneficial for performance.[1,2] For the RE testing, the participant ran at five pre-selected velocities (12 - 16 $km \cdot hr^{-1}$)[1] for at least five minutes except for the 16 $km \cdot hr^{-1}$ stage which he could only sustain for three minutes. The master athlete also achieved near $\dot{V}O_{2max}$ values while running at 16 $km \cdot hr^{-1}$ at 0% grade for 3 minutes (46.0 mL/kg/min), with a blood lactate values of 14.4 $mmol \cdot L^{-1}$. The running velocities of 12 - 16 $km \cdot hr^{-1}$ correspond to running at 7.5, 8.1, 8.7, 9.3, and 9.9 miles per hour, respectively. The participant recovered between each stage (up to ten minutes) in the form of slow walking, standing, or sitting. Following a rest period after the final running economy stage the participant performed a $\dot{V}O_{2max}$ test.

The protocol used for the $\dot{V}O_{2max}$ test was designed to last 8–12 minutes. The participant self-selected a relatively strenuous running pace - a running speed associated with a rating of perceived exertion (RPE) of 13–14 on a Borg 6–20 RPE scale. This velocity was then used to commence the test and was held constant while grade was increased 2-2.5% with each stage every two minutes until volitional exhaustion. A 30-second interval containing the two highest 15-second O_2 consumption values was used to determine $\dot{V}O_{2max}$.[3]

Lactate and Respiratory Exchange Ratio

An intravenous catheter was placed in an antecubital vein. The catheter was used to perform blood draws during the testing; samples were collected immediately the end of each RE stage. Whole blood samples were then analyzed via a Lactate Plus Meter (Nova Biomedical Waltham, MA). We also assessed respiratory exchange ratio (RER; vCO_2/vO_2) as an indirect metric of aerobic vs. anaerobic metabolism to complement lactate measures.[4] We used visual inspection and linear regression lines (GraphPad Prism, version 8.0.1) to determine the breakpoint at which there was a large increase in blood lactate similar to previous investigations.[5] RER broke from linearity at the same velocity as LT (14 $km \cdot hr^{-1}$).

Body Composition

The participant's body composition was assessed via dual-energy x-ray absorptiometry (DXA; Hologic Horizon-A, Bedford, MA). Data were processed using IRIS™ Enterprise Connectivity Suite. The scanner was calibrated prior to the scan per manufacturer guidelines.

Comparison Values and Additional Results

Reference values for cardiorespiratory fitness on >70-year-old males were obtained from the Fitness Registry and the Importance of Exercise National Database (FRIEND).[6] Lactate threshold reference values for younger competitive runners were derived from Farrell and colleagues 1979 publication.[5] As noted the master athlete broke the record on December 15th, 2018. The marathon course was the Jacksonville Marathon. The course is USA Track and Field certified (FL10117EBM) and is considered to be flat. The master athlete also ran 2:55:17 at the

Scotiabank Toronto Waterfront Marathon on October 21st, 2018. He also ran 2:57:43 at the Rotterdam Marathon in April 8th, 2018. In addition to lipid values reported in the letter, the masters athlete presented an LDL of 84 mg/dL (2.2 $mmol \cdot L^{-1}$), HDL of 66 mg/dL (1.7 $mmol \cdot L^{-1}$), and triglycerides of 135 mg/dL (1.5 $mmol \cdot L^{-1}$). The only medication he reported taking was daily low-dose aspirin.

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