Physiological Profile of a 59-Year-Old Male World Record Holder Marathoner

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ABSTRACT

LEPERS, R., B. BONTEMPS, and J. LOUIS. Physiological Profile of a 59-Year-Old Male World Record Holder Marathoner. *Med. Sci. Sports Exerc.*, Vol. 52, No. 3, pp. 623–626, 2020. **Purpose:** This study assessed the cardiorespiratory capacity and running economy (RE) of a 59-yr-old ex-Olympian athlete who ran a marathon in 2:30:15 in 2019. The athlete retired from running at 32 yr old (best marathon performance: 2:13:59) for a 16-yr period after his participation at the Olympics. **Methods:** Heart rate (HR), oxygen uptake ($\dot{V}O_2$), ventilation (VE), blood lactate concentration (La), step frequency, and RE were measured during a treadmill-running test. **Results:** His HR_{max}, VE_{max}, La_{max}, and $\dot{V}O_{2max}$ were 165 bpm, 115 $L \cdot min^{-1}$, 5.7 $mmol \cdot L^{-1}$, and 65.4 $mL \cdot kg^{-1} \cdot min^{-1}$, respectively. At his marathon pace, his RE was 210 $mL \cdot kg^{-1} \cdot min^{-1}$ with a step frequency of 199 ± 0.55 $s \cdot min^{-1}$, and his $\dot{V}O_2$ corresponded to 91% of his $\dot{V}O_{2max}$. **Conclusion:** This study shows that despite a 16-yr break in training, this 59-yr-old former Olympian marathoner has managed to limit the age-related decline in performance to ~5% per decade. More generally, these data suggest that high-level endurance masters athletes can limit the age-related decline in endurance performance at least until the age of 60 yr and can preserve their ability to sustain high-intensity effort (>90% of $\dot{V}O_{2max}$) for long-duration (2–3 h) exercises. **Key Words:** AGING, RUNNING, MASTERS ATHLETE, OXYGEN CONSUMPTION, AEROBIC EXERCISE, ENDURANCE

Although physical exercise during youth and adulthood might help reach old ages with a remarkable aerobic fitness compared with sedentary individuals, keeping physical activity levels high in later years seems to be a prerequisite to attenuate the age-related decline in cardiorespiratory capacity (1). Masters athletes are unique in that they have chronically undertaken high levels of physical activity until an advanced age. These athletes strive to maintain performances they achieved at younger ages, although athletic performance inevitably declines with aging (2). Peak endurance performance is generally maintained until ~35 yr of age, followed by modest decreases until 50–60 yr, with progressively steeper declines thereafter (3). The masters athlete's model represents a valuable source of insight into human's ability to maintain peak physical performance and physiological function with aging.

In the present study, we evaluated the cardiorespiratory capacity and running economy (RE) of a 59-yr-old former Olympian athlete who ran a marathon in 2:30:15 in 2019, establishing a new single age marathon world record (www.arrs.run/SA_Mara.htm). This study is unique in the sense that this athlete had a 16-yr break in training after his participation at the Olympics at the age of 32 yr (best marathon performance: 2:13:59) before resuming at the age of 48 yr. Moreover, despite his long running break, his decline in performance over a 27-yr period (from 32 to 59 yr) corresponds to only 11%, a decrease that is exceptionally low since after 35 yr the decline in performance is generally of 7%–10% per decade.

METHODS

Subject. At the date of the evaluation (July 2019), the athlete was a 59-yr-old Irish Caucasian, living in Northern Ireland. He was 169 cm high and weighted 61.2 kg (his weight was around 64 kg during his thirties). His total body fat measured via dual-energy x-ray absorptiometry (Hologic QDR Series; Hologic Inc., Bedford, MA) was 10.9%. The athlete was an elite full-time runner from the age of 21 to 32 yr. He retired from running and any other type of structured exercise training after his participation at the 1992 Olympics marathon. After a 16-yr break, he resumed training at the age of 48 yr and competed in running events from 5 km to marathon. On April 7, 2019, the

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athlete ran the Rotterdam marathon in 2:30:15 (average speed 16.85 km·h^{-1}). Although the athlete did not have a precise training diary, he recognized that he could run up to 160 km·wk^{-1} during specific training periods for the marathon. The athlete's training routine usually consisted in running twice a day with a long run (25–30 km) on the weekend and no rest day. He did not perform any structured high-intensity training sessions as he reported preferring to race at local competitions in preparation for his main goals.

The athlete volunteered for the study and was informed about its nature and aims, as well as the associated risks and discomfort prior to giving his oral and written consent to participate in the investigation. The protocol was in conformity with the Declaration of Helsinki (last modified in 2013). The experimental protocol was approved by the Research Ethics Committee of Liverpool John Moores University.

Performance testing. Performance testing was performed on a motorized treadmill (HP Cosmos, Nußdorf, Germany) and consisted of a submaximal RE test followed by an incremental running test until volitional exhaustion (maximal oxygen consumption [$\dot{V}O_{2max}$] test). Oxygen uptake ($\dot{V}O_2$) was measured using indirect calorimetry via an automated open circuit system (Oxycon Pro; Carefusion, Hoechberg, Germany). Heart rate (HR) was monitored via a Polar V800 HR monitor (Polar Electro Oy, Kempele, Finland). We used the same testing protocol as Robinson et al. (4) but with higher running velocities. In brief, after completion of a 6-min warm-up at running velocities varying from 12 to 15 km·h^{-1}, the athlete ran at four preselected velocities (15, 16, 17, and 18 km·h^{-1}) for 5 min, with 5 min of passive recovery in between. After the last RE stage, the athlete performed the $\dot{V}O_{2max}$ test during which a velocity of 16 km·h^{-1} was held constant while the treadmill gradient was increased by 1% every minute until volitional exhaustion. A 30-s interval containing the two highest 15-s O_2 consumption values was used to determine $\dot{V}O_{2max}$. Blood lactate (La) was measured in finger-prick blood samples (50 μL) using a portable lactate analyzer (Lactate Pro2, Arkray, Japan). Measurement was performed before and 1 min after each RE stage and after the $\dot{V}O_{2max}$ test. A foot pod monitor (Stryd Powermeter, Boulder, CO) was attached to the left shoe during the RE submaximal test to evaluate stride parameters. The Stryd foot pod is valid and reliable for the monitoring of step length and step frequency at running speeds ranging from 8 to 20 km·h^{-1} (5).

RESULTS

The results of performance testing are presented in Figure 1. During the final increment of the $\dot{V}O_{2max}$ test, maximal HR was 165 bpm, maximal ventilation was 115 L·min^{-1}, maximal respiratory exchange ratio was 1.04, maximal lactate concentration was 5.7 mmol·L $^{-1}$, and $\dot{V}O_{2max}$ was 65.4 mL·kg^{-1}·min^{-1}. When comparing the athlete's $\dot{V}O_{2max}$ with the American College of Sports Medicine's average percentile values (6), the athlete ranked above the 99th percentile for his age-group.

RE values calculated during the RE submaximal test were 203, 211, 210, and 206 mL·kg^{-1}·km^{-1} at 15, 16, 17, and 18 km·h^{-1},

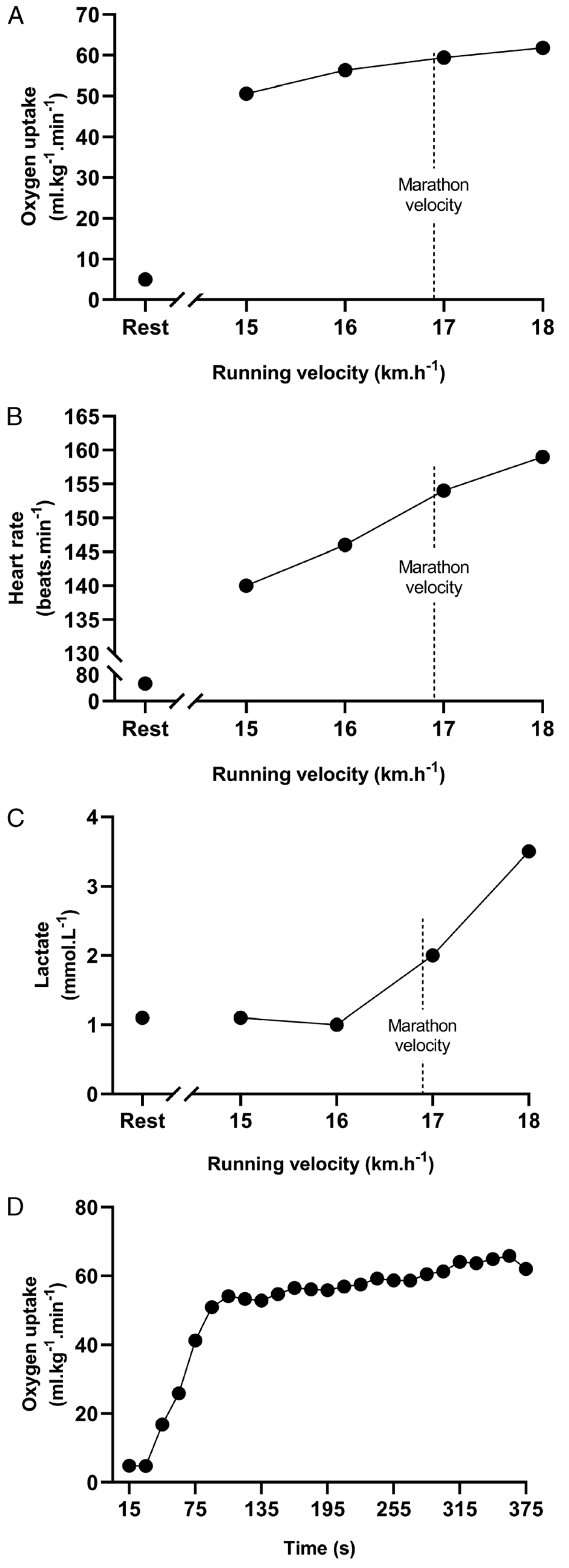

FIGURE 1—Physiological characteristics of the marathoner. $\dot{V}O_2$ (A), HR (B), and blood lactate values (C) obtained at different running velocities during the RE test. D, $\dot{V}O_2$ during the incremental running test. The dashed line represents the average speed of this runner during his record-breaking marathon performance (16.85 km·h^{-1}).

respectively. At his record marathon pace, his $\dot{V}O_2$ was approximately 59 mL·kg^{-1}·min^{-1} and corresponded to 91% of his $\dot{V}O_{2max}$, whereas HR corresponded to 93% of his HR_{max}.

DISCUSSION

This study reports the physiological profile of an ex-Olympian marathon runner who ran a marathon in 2:30:15 at the age of 59 yr despite a 16-yr break in training between the age of 32 and 48 yr.

This masters athlete has conserved a very high cardiorespiratory capacity as shown through a $\dot{V}O_{2max}$ of 65.4 mL·kg^{-1}·min^{-1}. In comparison, Heath et al. (7) found a mean $\dot{V}O_{2max}$ of 58.7 mL·kg^{-1}·min^{-1} in a group of highly trained runners 59 ± 6 yr old. $\dot{V}O_{2max}$ values of ~30 and ~45 mL·kg^{-1}·min^{-1} are classically reported in sedentary peers (8) and age-matched well-trained runners, (9) respectively.

This very high $\dot{V}O_{2max}$ for the age likely contributed to the exceptional marathon performance, associated with a very good specific endurance capacity at marathon pace (10). Indeed, the results showed that at his record marathon pace the athlete's $\dot{V}O_2$ corresponded to 91% of his $\dot{V}O_{2max}$, as it is reported in top class marathon runners (11). These data are in accordance with the study of Robinson et al. (4) who reported the physiological profile of a 70-yr-old masters athlete who ran a marathon in 2:54:23 (world record time for men over 70 yr) and was able to sustain a running velocity eliciting 93% of $\dot{V}O_{2max}$ during the marathon. These observations suggest that compared with young runners, master's runners might be able to run closer to their $\dot{V}O_{2max}$ for the duration of the marathon (12).

Running economy is clearly important to running performance (13). Despite his age, this masters athlete has maintained a good RE close to 210 mL·kg^{-1}·km^{-1} at his marathon pace. This RE value corresponds to those measured by Billat et al. (11) in top class male European marathon runners (marathon performance time <2:12:00) but remains higher to those measured in elite East African runners such as Eritrean runners who reach 180–190 mL·kg^{-1}·km^{-1} (14). Running economy has been found to decrease with aging in Olympic-caliber running athletes when they stop competitions (1). In our case study, the maintenance of a high training volume associated with a high step frequency (199 ± 0.55 s·min^{-1} at 17 km·h^{-1}) could explain the good RE of this masters athlete (15).

Could we predict the marathon running performance of the present athlete at the age of 70 yr? Supposing that this athlete will be able to maintain a high level of training in the future with a decline in $\dot{V}O_{2max}$ of 7% in the next decade (16), his $\dot{V}O_{2max}$ would be 60 mL·kg^{-1}·min^{-1} at 70 yr old. This extrapolated $\dot{V}O_{2max}$ value at the age of 70 yr would be much higher than that of the current over 70 yr marathon world record holder, which was 47 mL·kg^{-1}·min^{-1} (4), and to our knowledge close to the highest $\dot{V}O_{2max}$ value ever reported in the literature for this age (17). The age-related change in RE has been scarcely described in the literature. Everman et al. (1) found an increase in RE of about 5% per decade in former elite distance runners, but these runners had stopped competitions. We can expect that with training maintenance, the RE of the present athlete would increase by less than 3%, corresponding to a RE of 216 mL·kg^{-1}·km^{-1} at the age of 70 yr. Finally, if we assume that his ability to sustain an intensity close to 90% of $\dot{V}O_{2max}$ during the marathon would not decline with age, the equation of di Prampero et al. (18) predicts a running speed of 4.16 m.s^{-1} at the age of 70 yr, the equivalent of completing a marathon in 2 h 49 min—a time that is 5 min faster than the current marathon world record time for men over 70 yr.

A limitation of this study is the absence of comparative physiological data for this athlete when he was young at the top of his career. Such data would provide information on whether the subject's physiological capacities declined linearly or in a disparate manner. Furthermore, some differences in physiological parameters such as RE could occur between treadmill running and overground running, although they are probably minor for well-trained runners (19).

In conclusion, this study shows that despite a 16-yr break in training, this 59-yr-old former Olympian marathoner has managed to limit the age-related decline in performance by maintaining a high $\dot{V}O_{2max}$ and remarkable ability to sustain a high percentage of $\dot{V}O_{2max}$ during the marathon. More generally, these data suggest that it might be possible to limit the age-related decline in endurance performance to ~5% per decade at least until the age of 60 yr by maintaining a high training volume. Our data also suggest that endurance masters athletes could preserve their ability to sustain high-intensity efforts (at least 90% of $\dot{V}O_{2max}$) for long-duration (2–3 h) exercises. Further research is needed to better understand the conditions required to maintain such remarkable endurance capacity with aging.

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APPLIED SCIENCES

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