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Age-related decline in endurance running performance – An example of a multiple World records holder

Romuald Lepers, Thomas Cattagni

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27 **Abstract**

28

29 This study examined the age-related decline in endurance running performance of one of the
30 greatest master runners ever, Ed Whitlock. His running performances from 1500 m to
31 marathon were analyzed for five periods of 5 years from 65-69 years to 85-89 years. Despite
32 exceptional running performances for his advanced age, the rate of decline in his
33 performances increased after 80 years and was drastically amplified after 85 years.

34

35

36 **Key words:** Case report, master athlete, running, aging, marathon

37

38 **Introduction**

39

40 Age-related decline in endurance performance has been well described in literature
41 (Tanaka & Seals, 2003, Reaburn & Dascombe, 2008; Lepers & Cattagni, 2012; Lepers et al.,
42 2016a). The trajectory of this decline is relatively linear since the fourth decade and become
43 exponential after the seventh decade (Rittweger et al., 2009). This accelerated decline
44 sometimes referred to as a “breakpoint” may be explained by several factors such as a
45 reduction of the pool of older competitors, a decrease in the amount and intensity of training
46 or a fading of integrative physiological capacity though training level is maintained (Lazarus
47 & Harridge, 2017).

48 The age-related decline in athletic performances is generally assessed by analyzing,
49 for each age-group, world record performances or top finishers in one single event such as
50 world championships. However, these transversal analyses present some limitations because
51 the performances do not belong to the same person and do not correspond to the same
52 generation of athletes. Longitudinal studies would be more appropriated to describe the
53 decline in performance with age but unfortunately, longitudinal studies are scarce in the
54 literature (Trappe et al., 1996; Knechtle et al., 2010). Trappe et al. (1996) investigated runners
55 between 46 and 68 years and found that aerobic capacity of highly trained middle-aged males
56 declined by 5-7% per decade. Knechtle et al. (2010) reported that the running speeds of a 86
57 years master runner (winner of the European half-marathon Championship in the 85-89 age-
58 group) gradually slowed since the age of 64, with a larger decline after 80 years.

59 In the present paper, we propose to analyze the age-related decline in endurance
60 running performance of one of the greatest master runners ever, Ed Whitlock (EW), (1931-
61 2017). EW recently died of prostate cancer one week after his 86th birthday. Before that, the
62 Canadian master athlete was the first person over 70 years old to run a marathon in less than

63 three hours. At the age of 85, he was also the oldest person to run a marathon in less than four
64 hours. The main aim of this study is to describe the age-related decline in running
65 performance of EW. We more specifically focused on EW's performance after 65 years old
66 because he held his world records in age-groups from 65-69 years onwards.

67

68 **Methods**

69

70 Data were collected from the following websites: [http://www.world-masters-](http://www.world-masters-athletics.org)
71 [athletics.org](http://www.world-masters-athletics.org) ; <https://www.mastersrankings.com> and <http://www.arrs.net>.

72 To date, EW still held more than 30 age-class world records on road and track
73 running. EW had a late-life career as a marathoner. He ran a 4:31 mile in high school then ran
74 little in college because of an Achilles tendon injury, and quit running at age 21 yrs when he
75 started to work. He resumed running at his 40's and became a world-class masters runner at
76 800 m and 1500 m. He did his first marathon at age 46 yrs and had his personal best on the
77 marathon at age 48 (2h31min23s). After winning the World masters 1500 m title at age 48
78 yrs, he lost the incentive to train and again stopped running. After retiring, EW took up
79 running again. EW said, "I realized in my late 60s that this silly objective of being the first
80 person over 70 yrs to get under 3h in the marathon was just sitting there waiting for
81 someone." ([http://www.runnersworld.com/ed-whitlock/masters-marathon-legend-ed-](http://www.runnersworld.com/ed-whitlock/masters-marathon-legend-ed-whitlock-dies-at-86)
82 [whitlock-dies-at-86](http://www.runnersworld.com/ed-whitlock/masters-marathon-legend-ed-whitlock-dies-at-86)).

83 The running performances were considered for the categories corresponding to a 5-
84 year period as follows: 65-69 years, 70-74 years, 75-79 years, 80-84 years and 85-89 years.
85 The following running distances were considered: 1500 m (indoor and outdoor), 3000 m
86 (indoor and outdoor), 5000 m, 10 km, 21 km and the marathon (42 km). The age-related
87 decline in performance was specifically examined for 1500 m (indoor and outdoor, pool data),

88 5000 m, 10 km and marathon (42 km), and was expressed as the age-related decline in
89 running speed for these four distances.

90

91 **Results**

92

93 The most representative running performances of EW are shown in table 1. The mean
94 decrease in running performance between each 5-year period from 65-69 years remained
95 inferior to 5% until 75-79 years but was more pronounced after 80 years, reaching 13.4%
96 between 80-84 years and 85-89 years. Figure 1 shows the age-related decrease in running
97 performances during a 20-year period between 65 and 85 years. The running speed for the
98 different events declined with advanced age but the decline was more pronounced after 80
99 years old.

100

101 **Discussion**

102

103 The running performances of EW after 65 years old are exceptional. One of the most
104 impressive performances remains maybe his running time at the marathon set at the age of 73
105 yrs when he ran 2h54min48s. The performance corresponding to a running speed of $4.02 \text{ m}\cdot\text{s}^{-1}$
106 ¹ is only 30% lower than that of the actual absolute world record ($5.72 \text{ m}\cdot\text{s}^{-1}$, 2h02min57s) and
107 was considered, according to the model proposed by Vanderburgh (2015), as the fastest age-
108 adjusted marathon world records of all time (age-adjusted time: 2h02min42s). It has also been
109 estimated that the maximum oxygen uptake ($\text{VO}_{2\text{max}}$) of EW at 80 years of age was close to
110 $50 \text{ mlO}_2\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ (Lepers et al. 2013), that is much higher than the average $\text{VO}_{2\text{max}}$ observed
111 by Trappe et al (2013) in octogenarian endurance athletes ($\sim 38 \text{ mlO}_2\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$).

112 Besides his exceptional performances during his last two decades of life, there was an

113 accelerated decline in his performances after 80 years. The mean decline from 1500 m to
114 marathon reached 13% during the 5-year period between 80 and 85 years, whereas it was only
115 around 5% under 80 years. Knechtle et al. (2010) reported similar observation for a well-
116 trained master athlete, who presented an increased rate of decline in half-marathon
117 performance at the age of 82 yrs. The reason for this accelerated decline in performances at
118 the beginning of 80's in master athletes are not clear. Potential age-related changes in
119 physiological determinants of endurance exercise performance have been well described in
120 literature (Lepers et al. 2016a, Tanaka and Seals, 2003). Reductions in VO_{2max} , lactate
121 threshold and exercise economy are closely related to reductions in exercise training volume
122 and intensity. The changes in the physical (e.g. prevalence of injuries) and behavioral (e.g.
123 reduction in motivation to train) characteristics of training of the endurance master athletes
124 with age can also be implicated. A possible fading of integrative physiological capacity after
125 80 years, though training levels remain appropriated for age, should require more attention by
126 exercise physiologists.

127 We do have some information about EW's training. In interviews (Video available at
128 the address: https://www.youtube.com/watch?v=65dNE_BMTNc), EW said things like: "I
129 don't have a manager. I don't have a coach. I don't have a trainer. I don't use heart monitors.
130 I don't take any supplements." When at the height of marathon training, Whitlock did
131 cemetery loops for 3 hours a day, every day; doing more than 140 miles per week. However,
132 EW had a competitive spirit, He said: "Age-grading tables are a great motivator. My main
133 interest in them is to see if I'm going downhill faster than the tables say or see if I can beat the
134 tables." Even if, there is few scientific evidence on the way to train master athletes, especially
135 elderly master athlete (Borges et al. 2016), EW would have probably had benefits to train
136 with a coach for master athletes.

137 The presence of an accelerated decline in endurance performance after 80 years old
138 needs to be confirmed by other longitudinal studies for other endurance activities such as
139 swimming and cycling. Indeed, previous studies suggested that age-related decline in
140 endurance performance depended on the locomotion mode, with a less pronounced decline in
141 cycling compared with running or swimming (Bernard et al., 2010; Lepers et al., 2010; Lepers
142 et al., 2016b, Lepers et al., 2017).

143 In conclusion, the running performances of EW from 1500 m to marathon from 65 to
144 85 years were exceptional. His performances showed a more pronounced drop after 80 years
145 old. However as previously mentioned, EW died at 86 years old from prostate cancer and this
146 could have had a significant impact on the EW's running performances during the last years of
147 his life, especially after 85 years.

148

149 **Conflict of interest**

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151 The authors report no conflicts of interest associated with this manuscript

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155 **References**

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Age Group	1500 m		3000 m		5000 m	10 Km	21 km	Marathon	Mean difference with previous age group
	Outdoor (min:s,)	Indoor (min:s,)	Outdoor (min:s,)	Indoor (min:s,)	(min:s,)	(min:s,)	(h:min:s)	(h:min:s)	
65-69 yrs	04:46,1				17:38,5	36:31,5	01:19:32	02:51:02	
70-74 yrs	05:07,9			10:52,4	18:33,4	38:04,1	01:22:23	02:54:48	4.7 ± 1.8 %
75-79 yrs		05:20,0	11:10,4	11:17,2	19:07,0	39:25,2	01:29:26	03:04:54	4.3 ± 1.9 %
80-84 yrs		05:48,5	12:13,6	12:08,9	20:58,1	42:39,9	01:37:38	03:15:54	8.1 ± 1.4 %
85-89 yrs	06:38,2	06:38,9		13:42,0	24:03,9	51:07,5		03:56:34	13.4 ± 2.9%

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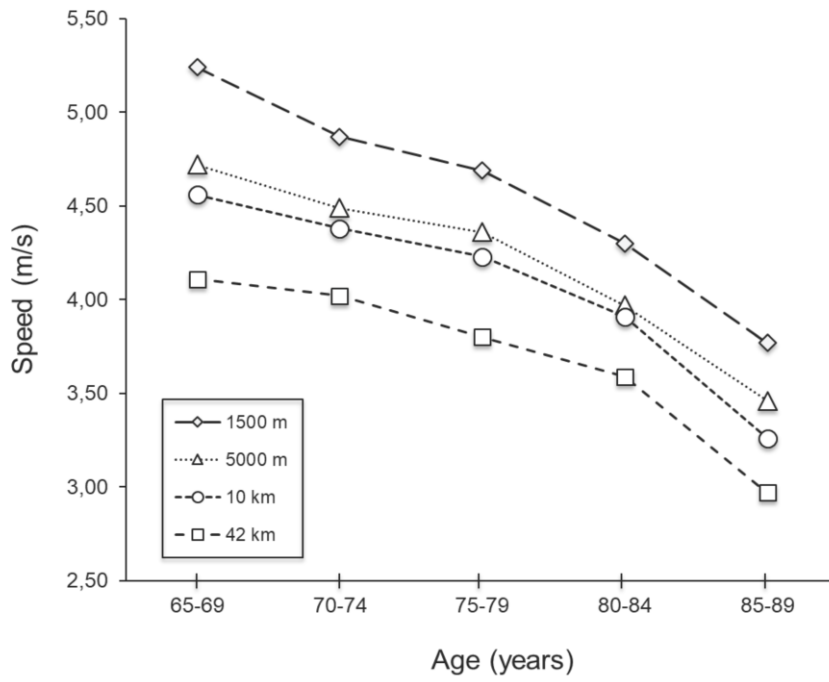
Table 1. Selection of representative running performances of Ed Whitlock. In bold : Current world records.

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Figure captions

Figure 1

Ed Whitlock's running speed as function of age for different events. The decline becomes more predominant after 80 years old.



226 Figure 1