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Centenarian athletes: Examples of ultimate human performance?

Romuald Lepers[1], Paul J. Stapley[2], Thomas Cattagni[3]

[1]CAPS UMR1093, INSERM, Univ. Bourgogne Franche-Comté, F-21000 Dijon, France
[2]Neural Control of Movement Laboratory, School of Medicine, Faculty of Science, Medicine and Health, University of Wollongong, Australia
[3]Laboratory Movement, Interactions, Performance EA 4334, University of Nantes, UFR STAPS, Nantes, France

Address correspondence to: T. Cattagni, UFR STAPS, Université de Nantes, Laboratoire 'Motricité, Interactions, Performance' EA 4334, 25 bis Boulevard Guy Mollet - BP 72206 44 322 Nantes cedex 3, France. Tel: +(33) (0) 2 51 83 72 32; Fax: +(33) (0) 2 51 83 72 10. Email: thomas.cattagni@univ-nantes.fr

Abstract

Background: some centenarians are engaged in regular physical activity and sometimes in sporting events.
Objective: we aimed to identify world records of centenarian athletes in several sports and determine which represented the best performance when compared to all-age world records, all disciplines taken together.
Methods: all of the best performances achieved by centenarians were identified and compared in three disciplines: athletics, swimming and cycling. The performances were considered as an average of the respective speeds, except for jumping and throwing events for which the maximum distances performed were considered. Within each discipline, the decline in performance of centenarian athletes was expressed as a percentage of the world record for that discipline. In total, 60 performances of centenarian athletes were found. These performances belong to 19 individuals: 10 in athletics, 8 in swimming and 1 in cycling.
Results: the centenarian world record performed by Robert Marchand in one hour track cycling appears to be the best performance (−50.6% compared with the all-age world record in this discipline) achieved by a centenarian.
Conclusions: although the physiological characteristics of Robert Marchand are certainly exceptional, his remarkable performance could also be due to the lower age-related decline for cycling performances compared with running and swimming. Our observations offer new perspectives on how the human body can resist the deleterious effects of ageing.

Keywords: *centenarian, sporting performance, master athletes, ageing, health*

Introduction

Centenarians that were themselves Olympians will get to see the 25th Olympics this year, some 80 years or so after they competed. The continuous increase in life expectancy over the last decades has contributed to the growth in the number of centenarians in the world's population [1, 2]. For example, in 2015 the Queen of England sent some 9,736 wishes of congratulations to centenarians, compared to just 3,000 in 1952 when she came to the throne [3]. Even if the total number of centenarians in the world remains uncertain, in 2013 the United Nations' *World Population Ageing 2013* estimated that there were around 4,41,000 living centenarians worldwide (i.e. 6.2 centenarians per 1,00,000 people) [2]. In 2010, more than 80% of US centenarians were female [4]. Centenarians are the fastest growing demographic in much of the developed world [5]. By 2050, it is expected that there will be around 3.4 million centenarians worldwide [2]. Centenarians are often considered as models of successful healthy ageing [6]. Some of them reach this age milestone while maintaining notable health indices. They preserve a high level of physical activity and therefore achieve remarkable sporting performances considering their age.

In recent times centenarians have even begun to participate in sporting competitions worldwide, becoming icons of healthy ageing and provide evidence that it is never too late to start exercising and reap the benefits of regular exercise [7].

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Fauja Singh, one of the most famous centenarian athletes, was *a priori* the first to finish a marathon despite his performance not having yet been approved by the *World Master Athletics Association* (i.e. the association that validates master athlete performances in athletics). In 2014, the French cyclist Robert Marchand (102 years) set the hour record in track cycling in the 100–104-year age group. In the same year, the Japanese swimmer Mieko Nagaoka set several swimming world records (distances from 50 m to 1500 m) in the 100–104-year age group.

Even though we may associate the above mentioned (and other) performances of centenarian athletes with an outstanding human capacity, the age-related decline in performance of these centenarian athletes is not actually known. Moreover, it would be interesting to know who, of the centenarian athletes across different disciplines, attained the best performance in comparison to the respective world records of their disciplines.

Method

In order to investigate these two aspects of centenarian performances, we identified and compared all of the best performances achieved by centenarians in three disciplines: athletics, swimming and cycling. Data were collected from the following websites of the international association or federations: http://www.world-masters-athletics.org for athletics; http://www.fina.org/content/masters-records for swimming and http://www.uci.ch/track/about for cycling. Each record performance (centenarians or non-centenarians) measured in time was expressed as an average speed over each distance (i.e. for 60 m running, 50 m swimming or 1 h track cycling, etc.). For jumping and throwing events, the performance was defined using the maximum distance obtained. In total, 60 performances of centenarian athletes were found (20 in athletics, 39 in swimming and 1 in cycling). These performances belong to 19 individuals: 10 athletes in athletics (9 males and 1 female), 8 athletes in swimming (5 males and 3 females) and 1 male athlete in cycling.

Within each discipline, the decline in performance of centenarian athletes was expressed as a percentage of the world record for that discipline, as follows:

$$\textit{Decline in performance}\ (\%) = \frac{\textit{Performance at 100 yrs or more} - \textit{World Record}}{\textit{World record}} \times 100$$

Results

The results are presented in Table 1. In athletics, the best centenarian performance (i.e. the lowest percentage decrease between the world record and the centenarian record) among men was found in the high jump (−63.3%) and in the shotput (−81.9%) for women. For running, only male performances were found and the lowest decrease for a centenarian in comparison to the world record was observed in the 100 m (−64.5%). In swimming, the lowest decrease for a centenarian was observed in the 50 m backstroke for males (−73.0%) and females (−71.2%). The centenarian world record performed by Robert Marchand in track cycling appears to be the best performance (−50.6% compared with the hour world record) achieved by a centenarian, all disciplines taken together.

Discussion

Previous studies have shown that athletic performance is maintained until 35 years of age, followed by linear decreases to 70–80 years of age ranging from 7 to 14% per decade, depending on the discipline. After this threshold of age, the performances in running tend to plummet, whereas the performances, for example, in throwing decline much more gently [8]. We found that the average decline in performance of centenarian athletes was 78% in comparison with the initial world record. Our methods of comparing records of each centenarian with the corresponding world record of that discipline provide a powerful means of assessing their performance using robust criteria. Ideally however, further information could be gained by comparing their centenarian record with each athletes' own record. This, however, is impossible as we did not have access to that information.

Several performances completed by Fauja Singh in athletics were not considered in the present report because they are unofficial. His best performance in comparison with the respective world record was achieved in the 100 m (−59.1%, 23.4s) while, for instance, the decrease in his marathon performance was 75.7%.

The performance of the centenarian cyclist Robert Marchand is outstanding and corresponds to an age-related decline in performance of less than 8% per decade for more than 6 decades. This lower age-related decline for a cycling event is consistent with previous work showing that the age-related decline in cycling performances was less compared with running and swimming [9, 10]. Irrespective of the specificity of the locomotion type, Robert Marchand has certainly shown exceptional physiological characteristics (e.g. muscular and cardiorespiratory functions) for his age [7]. This is in agreement with previous observations showing that centenarians have significant limitations to gas exchange across the lungs during exercise but this limited oxygen transport is tempered by improved skeletal muscle cycling efficiency [6].

Given the increased number of centenarians worldwide, the increased participation rate of master athletes in competitions [10] and the development of specific competitions for master athletes, it is very likely that the number of centenarian athletes will increase in the coming years leading to progress in their performances. Only two performances of centenarian athletes were found in the 105–109-year age group while a performance of a supercentenarian (age > 110 years) athlete has never been observed so far. We expect in the near future however, to observe the first sporting performance for a supercentenarian athlete.

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Table 1. Overview of the centenarian athlete performances compared with the respective world records in athletics, swimming and running

	World Record Holders (year)			100 year-old performers (year)				
Athletics-Running								
Men								
		Time (s)	Speed (m/s)		*Age group*	Time (s)	Speed (m/s)	Change (%)
60 m Indooor	Maurice Green (1998)	6.29	9.54	Everett Hosack (2002)	100–104	27.29	2.20	−77.0
100 m	Usain Bolt (2009)	9.58	10.44	**Donald Pellmann (2015)**	**100–104**	**26.99**	**3.71**	**−64.5**
				Hidekichi Miyazaki (2010)	100–104	29.83	3.35	−67.9
				Stanislaw Kowalski (2015)	105–109	34.5	2.90	−72.2
				Hidekichi Miyazaki (2015)	105–109	42.22	2.37	−77.3
200 m	Usain Bolt (2009)	19.19	10.42	Philip Rabinowitz (2004)	100–104	77.59	2.58	−75.3
400 m	Michael Johnson (1999)	43.18	9.26	Erwin Jaskulski (2003)	100–104	221	1.81	−80.5
1500 m	Hicham El Guerrouj (1998)	206	7.28	Leslie Amey (2000)	100–104	1006.41	1.49	−79.5
Athletics-Jumping								
Men								
		Distance (m)				Distance (m)		
Long jump	Mike Powell (1991)	8.95		Donald Pellmann (2015)	100–104	1.78		−80.1
High jump	Javier Sotomayor (1993)	2.45		**Donald Pellmann (2015)**	**100–104**	**0.9**		**−63.3**
Shotput	Randy Barnes (1990)	23.12		Donald Pellmann (2015)	100–104	6.56		−71.6
				Stanislaw Kowalski (2015)	105–109	4.27		−81.5
Athletics-Throwing Men								
Discus throw	Jürgen Schult (1986)	74.08		Donald Pellmann (2015)	100–104	14.86		−79.9
				Stanislaw Kowalski (2015)	105–109	7.5		−89.9
Hammer throw	Yuriy Sedykh (1986)	86.74		Trent Lane (2011)	100–104	11.32		−86.9
Javelin throw	Jan Zelezny (1996)	98.48		Takashi Shimokawara (2007)	100–104	12.42		−87.4
Women								
Shotput	Natalya Lisovskaya (1987)	22.63		Ruth Frith (2010)	100–104	4.1		−81.9
Discus throw	Gabriele Reinsch (1988)	76.8		Ruth Frith (2010)	100–104	9.3		−87.9
Hammer throw	Anita Wlodarczyk (2015)	81.08		Ruth Frith (2010)	100–104	11.3		−86.1
Javelin throw	Barbora Spotakova (2008)	72.28		Ruth Frith (2010)	100–104	6.43		−91.1
Swimming								
Men								
Freestyle								
		Time (s)	Speed (m/s)			Time (s)	Speed (m/s)	
50 m (SC)	Florent Manaudou (2014)	20.26	2.47	Jaring Timmerman (2009)	100–104	76.92	0.65	−73.7
				Tom Lane (1995)	100–104	126.66	0.39	−84.0
				Jaring Timmerman (2014)	105–109	172.48	0.29	−88.3
100 m (SC)	Amaury Leveaux (2008)	44.94	2.23	Jaring Timmerman (2009)	100–104	182.22	0.55	−75.3
				Tom Lane (1995)	100–104	272.29	0.37	−83.5
50 m (LC)	Cesar Celio (2009)	20.91	2.39	John Harrison (2014)	100–104	91.19	0.55	−77.1
				Tom Lane (1995)	100–104	100.46	0.50	−79.2
100 m (LC)	Cesar Celio (2009)	46.91	2.13	John Harrison (2014)	100–104	203.1	0.49	−76.9
				Tom Lane (1994)	100–104	245.98	0.41	−80.9
Backstroke								
50 m (SC)	Florent Manaudou (2014)	22.22	2.25	Jean Leemput (2014)	100–104	86.68	0.58	−74.4
				John Harrison (2014)	100–104	89.78	0.56	−75.3

Continued

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Table 1. Continued

	World Record Holders (year)			100 year-old performers (year)				
				Jaring Timmerman (2009)	100–104	105.59	0.47	−79.0
				Tom Lane (1995)	100–104	122.52	0.41	−81.9
				Jaring Timmerman (2014)	105–109	189.55	0.26	−88.3
100 m (SC)	Nicholas Thoman (2009)	48.94	2.04	Jean Leemput (2014)	100–104	206.09	0.49	−76.3
				John Harrison (2014)	100–104	219.53	0.46	−77.7
				Jaring Timmerman (2009)	100–104	231.54	0.43	−78.9
				Hans Hahn (2008)	100–104	301.82	0.33	−83.8
50 m (LC)	Lian Tancock (2009)	24.04	2.08	Jean Leemput (2014)	100–104	89.13	0.56	−73.0
				John Harrison (2014)	100–104	92.2	0.54	−73.9
				Tom Lane (1994)	100–104	110.73	0.45	−78.3
100 m (LC)	Aaron Peirsol (2009)	51.94	1.93	Tom Lane (1994)	100–104	253.84	0.39	−79.5
200 m (LC)	Aaron Peirsol (2009)	111.92	1.79	Tom Lane (1994)	100–104	544.31	0.37	−79.4
Women								
Freestyle								
50 m (SC)	Ranomi Kromowidjojo (2013)	23.24	2.15	Mieko Nagaoka (2009)	100–104	94.12	0.53	−75.3
100 m (SC)	Lisbeth Trickett (2009)	51.01	1.96	Mieko Nagaoka (2009)	100–104	210.49	0.48	−75.8
50 m (LC)	Britta Stefen (2009)	23.73	2.11	Mieko Nagaoka (2014)	100–104	101.88	0.49	−76.7
				Mary Maina (1994)	100–104	310.84	0.16	−92.4
100 m (LC)	Britta Stefen (2009)	52.07	1.92	Mieko Nagaoka (2014)	100–104	225.85	0.44	−76.9
200 m (LC)	Federica Pellegrini (2009)	112.98	1.77	Mieko Nagaoka (2014)	100–104	468.76	0.43	−75.9
400 m (LC)	Katie Ledecky (2014)	238.37	1.68	Mieko Nagaoka (2014)	100–104	996.8	0.40	−76.1
800 m (LC)	Katie Ledecky (2015)	487.39	1.64	Mieko Nagaoka (2014)	100–104	2284.3	0.35	−78.7
1500 m (LC)	Katie Ledecky (2015)	925.48	1.62	Mieko Nagaoka (2014)	100–104	4448.73	0.34	−79.2
Backstroke								
50 m (SC)	Etiene Medeiros (2014)	25.67	1.95	Mieko Nagaoka (2014)	100–104	98.71	0.51	−74.0
				Rosa Sellares (2010)	100–104	233.6	0.21	−89.0
100 m (SC)	Katinka Hosszu (2014)	55.03	1.82	Mieko Nagaoka (2014)	100–104	222.81	0.45	−75.3
200 m (SC)	Katinka Hosszu (2014)	119.23	1.68	Mieko Nagaoka (2014)	100–104	460.01	0.43	−74.1
50 m (LC)	Jing Zhao (2009)	27.06	1.85	Mieko Nagaoka (2014)	100–104	93.89	0.53	−71.2
100 m (LC)	Gemma Spofforth (2009)	58.12	1.72	Mieko Nagaoka (2014)	100–104	219.81	0.45	−73.6
200 m (LC)	Missy Franklin (2012)	124.06	1.61	Mieko Nagaoka (2014)	100–104	485.64	0.41	−74.5
Cycling								
Men								
		Distance (km)	Speed (m/s)			Distance (km)	Speed (m/s)	
1 h Track	Bradley Wiggins (2015)	54.526	15.15	**Robert Marchand (2014)**	**100–104**	**26.925**	**7.48**	**−50.6**

The three best centenarian athlete performances in comparison with their respective world records (i.e. the three lowest decreases between a world record and a centenarian athletic performance) are shown in bold text. SC: short course (25 m); LC: long course (50 m)

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The centenarian athletes must be seen not only as exceptional biological examples but also as evidence that it is never too late to be active [7]. We can only hypothesize that, as the number of centenarians grows and attitudes towards exercise changes in these older persons, the exceptional performances detailed here will become more commonplace, and may perhaps open new perspectives on how the human body can resist the deleterious effects of physiological ageing.

Key points

- Some centenarians preserve a high level of physical activity and achieve remarkable sporting performances considering their age.
- The average decline in performance of centenarian athletes was ~78%.
- The world record performed by Robert Marchand in track cycling appears to be the best performance achieved by a centenarian.
- The number of centenarian athletes will increase in the coming years leading to progress in their performances.
- The centenarian athletes must be seen as evidence that it is never too late to be active.

Conflicts of interest

None declared.

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