The Master Triathlete

14

Romuald Lepers

14.1 Introduction

Master triathletes are generally defined as triathletes older than 40 years who systematically train and compete in triathlon events of various distances. These athletes can still achieve extremely high levels of performance. The Swiss woman Natascha Badmann won the South Africa Ironman triathlon in 2012 at 45 years old (becoming the oldest Ironman triathlon winner) and finished sixth at the Ironman World Championship the same year. In 2018, Hiromu Inada from Japan became the oldest man to ever finish the Ironman World Championship at 85 years old in a time of 16 h 53 min. These both examples of "young" or "old" master triathletes show how it is possible to push the limits of the interaction between aging and endurance performance. This chapter addresses the specific aspects of age-related declines in triathlon performance with a special focus on the performances of the best master triathletes because they represent a unique model for studying the effects of high levels of physical training in older individuals.

14.2 Increase in Participation of Master Triathlete

Over the last decades, there has been a continual increase in the number of master athletes for short- and long-distance triathlons. For both females and males, there was an important rise in relative participation among age groups >40 years. For example, at the Hawaii Ironman triathlon, master triathletes represented 31% of the total field for the males and 23% of the total field for females in 1986, while they represented 56% of the total field for males and 47% of the total field for females in

R. Lepers (✉)
Laboratoire INSERM U1093, CAPS, Faculté des Sciences du Sport, Université Bourgogne Franche-Comté, Dijon, France
e-mail: romuald.lepers@u-bourgogne.fr

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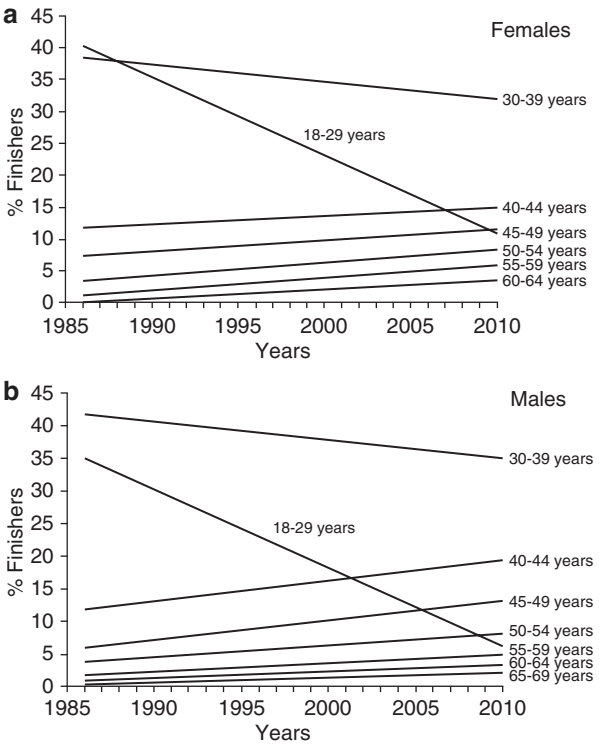

Fig. 14.1 Increase in participation of master triathletes at the Hawaii Ironman triathlon across the period of 1986 through 2010, for both females (**a**) and males (**b**). Reprinted with kind permission of the American Aging Association from Lepers et al. [1]

2010 [1] (see Fig. 14.1). In contrast, relative participation decreased among males and females <40 years, especially for the youngest age groups <30 years. It has been estimated that in all Ironman triathlons held worldwide in 2015 (≈11,000 female finishers and ≈47,000 male finishers), master triathletes represented 59% of the total field for the males and 54% of the total field for females [2]. Master triathletes are also well represented in short-distance triathlons. Sultana et al. [3] found that master athletes represented more than 50% of the total field for males and more than 40% of the total field for females at the 2006 and 2007 Olympic triathlon age groups world championships. The increase in participation of master athletes is not specific to triathlon. Indeed, increase in participation of both male and female athletes older than 40 years over the past decades has been also reported for marathon and ultra-marathon running [4–7].

Different factors could explain the increase in participation of master athletes in triathlon. The relative increase in participation of master triathletes in Ironman triathlon could result from a relative decrease in Ironman triathletes in the younger age groups (<40 years). Younger triathletes are maybe more attracted by shorter distances such as sprint or Olympic distances. Triathlon being an Olympic sport since 2000, it may have increased the popularity of the short distance especially in the young triathlete field [1]. With advancing age, triathletes naturally move towards longer distances where endurance and experience play a greater role in performance

than maximal aerobic capacity. Health, fitness benefits, enjoyment and social factors are the primary drivers sport involvement with advancing age [8]. In addition, with the increase in life expectancy and training facilities, the increased participation of master triathletes, especially for those older than 60 years old, may be a reflection that these athletes, who may in some cases be retired, have more available time and resources at their disposal to train and therefore to compete [9]. However, sporting background, social category and working profession of the master triathletes all remain unknown. Some may have the experience of many years of training and competition, while others only begin as they approach middle age and beyond.

14.3 Improvement of Master Triathletes' Performances

Age-related declines in triathlon performances have been well described in the literature for both short- and long-distance events. Triathlon performance appears to be maintained until 35–40 years of age, followed by modest decreases until 50 years of age and progressive decrease in performance thereafter. For example, the age-related declines in total Ironman triathlon performance with advancing age are about 12–13% per decade for males and 14–15% per decade for females [1]. The best male master triathletes tend to reduce the age-related decline to 10% per decade until 60 years of age (see Table 14.1).

The age of peak performance in Ironman triathlon is around 30–35 years for both females and males for elite triathletes, while the fastest race times are usually achieved between 25 and 45 years for non-elite triathletes [10, 11]. Interestingly, it has been reported that the age of the elite Ironman triathletes has increased over the past decades. For example, the age of the top ten finishers at the Hawaii Ironman triathlon increased over the last three decades from 27 to 34 years for the males and from 26 to 35 years for females [12]. It is now not uncommon for triathletes over 40 years to finish on the podium of an Ironman triathlon. For example, Cameron Brown won the 2016 New Zealand Ironman when he was 43 years old and still finished third 2 years later. Similarly, the Belgian Marino Vanhoenacker won the 2016 Austria Ironman when he was 40 years old and won the 2018 Australia Ironman when he was 42 years old. These two elite triathletes have had very long sporting careers and have remained at the highest level for about 15 years. Cameron Brown, who started triathlon when he was 20 years old, won his first Ironman when he was 28 years old, and Marino Vanhoenacker won his first Ironman when he was 27 years old.

The increase in participation of master triathletes in triathlon events over the past decades has been accompanied by an improvement in their performance at a faster rate than young triathletes, especially for the oldest categories [1, 13, 14]. For example, at the Hawaii Ironman triathlon, the best male finishers in the age group 60–64 years improved their total performance by 20% during the 1985–2010 period ([1], see Fig. 14.2).

Several reasons may explain the improved performances of master triathletes. Firstly, the increase in participation of the master triathletes increased the

Table 14.1 Total time records and corresponding split times for male and female age groups at the Hawaii Ironman triathlon

	Age groups (years)										
	PRO	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84	85–89
Male—time (h:min:s)											
3.8 km swim	50:37	1:01:53	1:03:18	56:07	1:01:09	58:10	1:04:42	1:47:46	1:31:39	1:49:34	1:51:26
180 km cycle	4:16:05	4:34:39	4:36:55	4:42:03	4:45:31	5:05:23	5:28:59	5:47:33	6:22:23	7:42:08	8:02:40
42 km run	2:41:32	2:59:18	3:09:02	3:21:19	3:19:35	3:36:26	4:01:18	3:52:47	5:02:30	5:41:52	6:28:18
Total	7:52:39	8:41:22	8:55:33	9:05:38	9:14:24	9:46:54	10:44:31	11:45:05	13:06:04	15:38:25	16:53:50
(Year)	(2018)[a]	(2013)[b]	(2018)[c]	(2018)	(2018)	(2017)[d]	(2013)	(2011)	(2018)	(2012)	(2018)
Female—time (h:min:s)											
3.8 km swim	57:26	1:09:26	1:03:29	1:06:50	1:06:12	1:21:11	1:11:55	1:15:22	1:45:05	–	–
180 km cycle	4:26:07	4:58:41	4:58:36	5:16:28	5:19:27	5:52:33	6:02:33	6:49:58	7:25:17	–	–
42 km run	2:57:05	3:18:45	3:15:22	3:41:36	3:57:57	4:19:50	5:03:27	5:28:42	6:19:43	–	–
Total	8:26:16	9:32:05	9:23:26	10:12:03	10:33:10	11:41:45	12:28:44	13:42:50	15:54:16	–	–
(Year)	(2018)[e]	(2011)[f]	(2018)	(2018)	(2013)	(2018)	(2018)	(2017)	(2005)	–	–

PRO professional category
[a]Patrick Lange (32 years old)
[b]Dave Scott (40 years old) did 8:24:32 (1994) in PRO category
[c]Cameron Brown (46 years old) did 8:25:30 (2018) in PRO category
[d]Rob Barel (was born in December so he was 59 years the race day)
[e]Daniela Ryf (31 years old)
[f]Mareen Hufe (40 years old) did 8:25:30 (2018) in PRO category

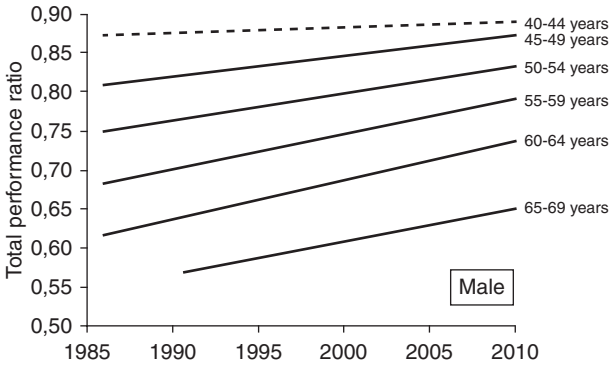

Fig. 14.2 Changes in total time performance at the Hawaii Ironman triathlon across the years for best male master triathletes. A performance ratio equal to 1 corresponds to the performance of the top ten elite triathletes (<40 years old). Solid lines represent conditions where the slopes of the linear regressions were significantly different ($P < 0.01$) from zero. Dashed lines indicate the slopes of the linear regressions were not significantly different from zero. Reprinted with kind permission of the American Aging Association from Lepers et al. [1]

probability of finding better triathletes in the older age groups. In addition, the increased facilities for older athletes, the improvement of master athletes coaching, training techniques, nutritional strategies or equipment may also explain the improved performance of master triathletes [9, 15–18]. Master triathletes that have attained good results and positive outcome have increased levels of motivation to train and compete in triathlon events and their competitive spirit [19–21].

14.4 Effects of Event Duration and Type of Triathlon

The age-related declines in triathlon performance seem to depend on event duration. It has been shown that the magnitude of the decline in cycling and running performances with advancing age was less pronounced for Olympic distance triathlon compared to Ironman distance triathlon [22]. In contrast, the age-related decline in swimming performance was not influenced by triathlon duration. For the best master triathletes of 70–74 years, total finishing time is approximately 3 h for an Olympic distance triathlon, whereas it is around 12 h for an Ironman. Factors such as greater muscle fatigue and greater sensibility to muscle damage of older triathletes could explain the greater declines in cycling and running performance when exercise duration increases.

It has also been shown that the type of discipline (road bike versus mountain bike cycling and road running versus trail running) could influence the magnitude of age-related changes in triathlon performance [23]. Indeed, the rate of decline in performance with advancing age is greater for off-road triathlon (e.g. Xterra®) than for road-based triathlon. Reduction in power to weight ratio with advancing age, lower technical bike-handling skills and reduced ability to

modify the biomechanical components of running on trails could explain the greater decline for off-road triathlon of master triathletes [23].

14.5 Effect of Discipline: The Specificity of Cycling

Triathlon involving three disciplines (swimming, cycling and running) offers the possibility of comparing age-related declines in the three locomotion modes for the same athlete. Triathlon performance decreases in a curvilinear manner with advancing age, but it has been observed a smaller age-related decline in cycling performance than in running and swimming performances for both long- and short-distance events [22–25] (see Fig. 14.3). These findings suggest that the age-related declines in endurance performance are dependent to the mode of locomotion, although the cause for such discipline specificity remains not really clear. Several hypotheses have been proposed to explain the smaller decline in cycling performance with advanced age. Lepers et al. [22] proposed that mechanical power could explain these differences. Indeed, mechanical power output (P) is dependent upon the velocity (V) for running ($P = k.V$, k: constant), whereas it is dependent upon the third power of velocity for cycling ($P = k.V^3$). As changes in aerobic capacity with age are tied to reductions in P, these reductions with age would impact cycling velocity to a lower extent than running velocity. Other mechanisms can be proposed to explain the smaller decline in cycling performance compared with the decline in the two other disciplines: a lesser reduction in lactate threshold or economy during cycling relating to a greater training volume in cycling compared to running to limit the traumatic injuries, a greater muscle fatigue during running with age and a decrease in upper body flexibility with age during swimming. Although these assumptions remain speculative and require further investigations, these data suggest that cycling is the discipline for which it is easier to maintain the highest level of performance in triathlon with advancing age.

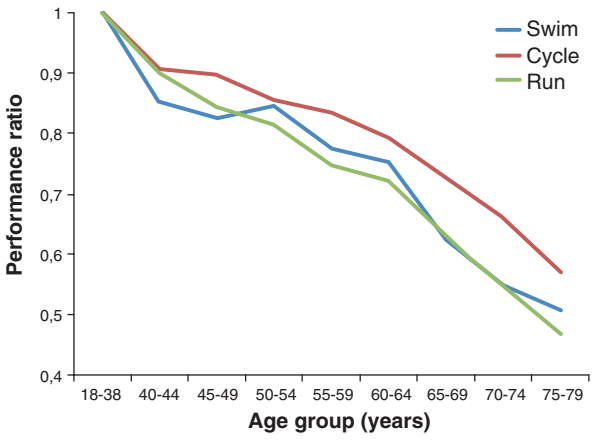

Fig. 14.3 Age-related decline in swimming, cycling and running performances at the 2017 Hawaii Ironman triathlon for the top five finishers of each age group. There was a lesser age-related decline in cycling performance compared with running and swimming after 40 years old

14.6 Sex Difference in Performance with Advancing Age

Sex difference in triathlon performance varied from 12% to 18% depending on the level of triathletes (elite versus age group) or the distance of the race [13]. Generally, time differences between sexes in swimming have been shown to be smaller than in cycling and running and could be explained in part by the biological difference in relative body fat (7–9% higher in females). Sex differences in performance are of biological origin, and the gap between elite males and females is unlikely to narrow naturally. However, several studies showed that the sex difference in triathlon performance increases with advanced age [13, 26]. For example, the sex difference in total event performance time at the Hawaii Ironman triathlon increased with advancing age from 55 years during the 2006–2008 period [26]. Data from Table 14.1 also show that sex difference in total performance at the Hawaii Ironman triathlon equals to 14% for age group 55–59 years, 16% for age group 65–69 years and 21% for age group 75–79 years. Similar findings have been observed for Olympic distance triathlon [27]. The reasons for the increased sex difference with age remain unclear and may result from physiological, sociological and psychological changes [28, 29]. The lower participation rate of female master triathletes, especially in the older categories, is likely to amplify the sex difference in performance above that due to physiological differences alone [30]. By comparison, since 2000 the sex difference in running performance at the New York marathon did not differ anymore across the age [6]. This relative stability of sex difference across the ages for running suggests that the age-related declines in physiological functions did not differ between females and males. These findings contrast with previous studies showing a greater decline in physiological determinants of endurance performance for females compared to males [29]. The increase in participation of female master triathletes associated with the appearance of well-trained females to the older age groups will inevitably reduce the gap between male and female master triathletes. In the near future, sex difference in triathlon performance should be the same for all age group categories, at least the best older triathletes.

14.7 Age-Related Changes in Physiology of the Master Triathlete

Both central (decreases in maximal heart rate, maximal stroke volume and maximal cardiac output) and peripheral (decreases in muscle mass and in maximal arteriovenous oxygen difference) factors contribute to age-related declines in triathlon performances. However, these physiological factors can be modulated by changing the volume and the intensity of master triathlete' training [7, 9, 31]. Among the three determinant factors of endurance exercise performance (i.e. maximal oxygen consumption, lactate threshold and exercise economy), the decrease in maximal oxygen consumption (i.e. VO_{2max}) seems to be the predominant contributor to the decline in endurance performance with advancing age [31]. It is generally admitted that VO_{2max} declines by ≈10% per decade after 40 years in healthy sedentary people. It is not

clear in the literature if the rate of decline is smaller or greater in master endurance athletes [32–34]. The greater rate of decline in VO_{2max} in master athletes compared to healthy sedentary adults could result from that of a greater baseline VO_{2max} with age as young adults and greater reductions in training with advancing age compared to non-trained adults. Some trained master athletes can still achieve high level of aerobic capacity even at a very advanced age. For example, it has been estimated that the VO_{2max} of the Canadian male runner (Ed Whitlock) who ran the marathon in 3 h 15 min at the age of 80 years was close to 50 ml/kg/min [35].

Reductions in the capacity to sustain a high fraction of VO_{2max}, evaluated by blood lactate threshold, and submaximal exercise economy may also contribute to the decrease in triathlon performance with advancing age. However, the decrease in running and cycling efficiency in master triathletes remains poorly understood. A higher energy cost of running in master triathletes (>40 years), compared to their young counterparts, has been observed by Sultana et al. [36]. These authors suggested that the higher energy cost of running in master triathletes could be due in part to a lower muscle power. Peiffer et al. [37] found that cycling efficiency was 11% lower and energy cost of running was 11% greater in master triathletes (60 years) compared with young triathletes (28 years). The difference was even more pronounced for the run (+22%) when values was scaled to lean body mass. Even if physiological data of well-trained master triathletes are missing in the literature, present data suggest that aging can influence exercise economy for both the run and cycle discipline. Future studies will need to focus on physiological characteristics of master triathletes and verify if they differ from other endurance master athletes. The inevitable age-related changes in physiology of master triathletes remain closely related with reductions in exercise training intensity and volume. The psychological (e.g. motivation to train hard) and physical (e.g. prevalence of injuries, see [38]) aspects of training of the master triathletes should also be considered in the age-related changes in performances.

14.8 Recovery of Master Triathlete

Master triathletes frequently said that they need more time for recovering from a hard training session or a competition. Chris McCormack, Australian triathlete and two-time winner of the Ironman World Championship, wrote in his book, “When I was twenty, I could jump out of bed after a few hours of sleep, throw some junk down my throat and run, bike and swim a ten-hour training day. If I tried to do that today (at 38 years old), I wouldn’t last six hours. You have to plan for more rest when you’re older” [39]. Unfortunately, scientific evidences of lower recovery capacities in master triathletes compared to young counterparts are missing. However, some studies suggest that while master athletes may show delays in the acute recovery of a number physiological parameters, the influence of this delayed acute recovery on subsequent physical performance seems to be minimal [40, 41]. However, despite restoration of physical performance at rates similar to younger athletes, master athletes perceive to take longer to recovery from a bout of

high-intensity exercise. These results suggest that coaches and master triathletes may have to allow for greater recovery durations between sessions to allow for psychological recovery in master triathletes. These data warrant the use of perceptual measures when monitoring the training load of master triathletes as physiological measures alone may not be sensitive enough to quantify recovery [41]. In addition, greater care may be required when training incudes exercise-related muscle damage as previous studies have suggested that this may lead to a delayed physical recovery in master athletes [42, 43].

In master athletes, the effects of dietary supplementation on recovery remain contradictory [15]. However, the role of antioxidants and micronutrients (mainly vitamins) during aging appears essential especially in master triathletes who are doubly exposed to oxidative stress. Indeed, the repetition of intensive physical exercises damaging to muscles, combined with increased oxygen consumption, and aging are factors conducive to oxidative stress. Very few studies have tested the potential beneficial effects of vitamin supplementation in master athletes. Although the ingestion of vitamin C or E alone seems to have no effect on muscle recovery, the use of complexes of antioxidants including several vitamins and minerals could be beneficial for recovery, in particular when training involves eccentric exercises well known to induce muscle damage [42].

14.9 Conclusion

Despite the age-related changes in their physiology, master triathletes can still achieve high levels of performance in the three disciplines. Different factors such as the event duration, the type of triathlon and the locomotion mode should be considered in the age-related decline in triathlon performance. The best master triathletes have improved their performances over these last decades, and the question as to whether older triathletes have reached their limits in triathlon performance maybe raised. Additional information regarding their responses to different training regimes such as concurrent strength and aerobic training or high-intensity interval training, their recovery capacities, their specific nutritional requirements or their psychological profiles could help master triathletes to extend the limits of their endurance.

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