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AGE AND GENDER DIFFERENCES IN PERFORMANCE AT CROSS TRIATHLON WORLD CHAMPIONSHIPS

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Abstract

Introduction. Cross triathlon is a sport consisting of three segments: swimming, off-road cycling, and running. Our study analyses the differences in performance between genders and changes in performance in selected age categories at the ITU Cross World Championships held between 2011 and 2016. ***Material and methods.*** During this period, a total of 1,933 triathletes were analysed (1,472 men and 461 women). Two-way analyses of variance (ANOVA) were used to examine the impact of sex differences and age-related changes on performance (time, percentage of time, and performance ratio) in swimming, cycling, running, and total race. ***Results.*** The age groups with the highest level of participation were persons aged 40-44 and 45-49 years among men and women, respectively. With regards to performance in the different age groups, in men and women, its high level was maintained between 25 and 49 years, and it decreased significantly from the age of 50-54. In men, the best results in cycling and total race time were obtained in the 30-34 age group and in swimming and running in the 40-44 group. Women obtained the best results in running in the 25-29 age group, in cycling in the 30-34 group, and in swimming and total race time in the 35-39 group. ***Conclusions.*** The results of the study have confirmed that there is a demand for sports in 40+ age groups. As for performance in the different age groups, it was on a high level between 25 and 49 years and decreased significantly from the age of 50-54 onwards. According to these results, the sports training of these triathletes should be oriented so that they obtain their best results between 30 and 35 years of age.

Key words: competition, endurance, master category, aging

Introduction

Cross triathlon or X-tri is an off-road triathlon discipline that typically takes the form of a 1- to 1.5-km swim, a 20- to 30-km mountain bike race, and a 6- to 10-km trail run. The athletic challenge of the triathlon is thus combined with the uncertainty of the environment in which it is performed. It is a demanding yet also appealing format due to the natural environments in which these competitions usually take place.

This discipline first emerged on the Island of Maui (Hawaii) in 1996, to become the Xterra World Championships. Afterwards, the International Triathlon Union (ITU) organised its first Cross Triathlon World Championship in April 2011 in Extremadura, Spain, at an international centre for sports innovation, in a natural environment also known as "The Ring". Following this first world championship, the natural environments in which these types of races are held have been of high environmental and ecological interest. These have included Oak Mountain State Park (United States, 2012); the Hague (Netherlands, 2013); Zittau (Germany, 2014); Cala Ginepro, Sardinia (Italy, 2015); Lake Crackenback, Snowy Mountains (Australia, 2016); and Penticton (Canada, 2017).

Until now, scientific research focusing on the cross triathlon has been very limited compared to studies on conventional triathlons at different distances (sprint, Olympic, and long-distance), which have revealed differences in performance related to gender and age [1-6].

The majority of research on the cross triathlon format has been conducted at Xterra competitions. The variables that have been analysed include gender and performance [7], age and performance, performances in conventional road triathlons versus off-road triathlons over short distances [8], the economic impact of the participants in these competitions [9], or the athletic careers of triathletes [10].

The research which is the most similar to the current study, although it was conducted only with regard to males and at Xterra competitions, is the paper by Lepers et al. [8], which compared the cross triathlon and the conventional triathlon formats at short distances. The research suggested that the age-related decline in performance in the three segments was greater in the cross triathlon than in conventional triathlons. In addition, it was mainly in the road vs. mountain bike cycling segment that the age variable had a greater impact, possibly due to the high technical skills mountain biking requires.

Other studies have confirmed the importance of these technical requirements in off-road cycling [11] and also in trail running [12].

The decrease in age-related performance has been studied in each of the legs making up the cross triathlon: swimming in open water [13], trail running [12], and cycling [14].

In our paper, differences in participation according to gender and in performance based on gender and age group in Cross Triathlon World Championships are analysed from 2011 until 2016. Differences in performance in the different segments (swimming, mountain biking, and trail running) are also investigated.

Material and methods

Participants

A total of 1,933 triathletes (1,472 men and 461 women) participated in the 18-19 to 75-79 age group categories at the Cross Triathlon World Championships (ITU) from 2011 to 2016.

The data for analysis were obtained from the results of those competitions during a six-year period, published by the International Triathlon Union (ITU). The study involved the analysis of publicly available data so the informed consent requirement was waived. We analysed the performance of participants in different age groups during the competition, the results in the three segments of the cross triathlon (1- to 1.5- km swim, 20- to 30-km mountain bike race, and 6- to 10-km trail run), and the end time in the top ten men and women from each of the age groups. These age groups have been established by the ITU in five-year periods. The analysis presented in the current article focuses particularly on the 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, and 55-59 age groups; other groups were excluded due to their low participation rates.

Procedure

Data were averaged for the top 10 male and female triathletes in each year from 2011 to 2016, and the swimming, cycling, running, and total race performance times were converted to minutes. Then, the percentage of time that the triathletes spent on swimming, cycling, and running relative to the total race time was calculated. Finally, in order to examine the age-related declines in performance in swimming, cycling, running, and total race, a performance ratio was calculated as the mean time performance of the best performing age group divided by the individual performance time [5].

Statistical analysis

Data are reported as means (with standard deviations) in the text and the table and displayed as means (with standard errors) in the figures. Firstly, all the statistical assumptions were checked using common procedures. For instance, normality was examined by means of histograms and normal Q-Q plots. Afterward, two-way analyses of variance (ANOVA) were used to examine the effect of sex differences and age-related changes on performance (time, percentage of time, and performance ratio) in swimming, cycling, running, and total race. Subsequently, post-hoc analysis with the Bonferroni adjustment was used for pairwise comparisons. All statistical analyses were performed using SPSS version 21.0 for Windows. The statistical significance level was set at $p < 0.05$.

Results

From 2011 to 2016, a total of 1,933 triathletes (1,472 men and 461 women) participated in the 18-19 to 75-79 age group categories at the Cross Triathlon World Championships. Non-finishers represented 6.4 ± 6.4% (0.0-25.0%) of the race participants for the men and 3.9 ± 3.6% (0.0-12.5%) for the women. The age groups of 40-44 years and 45-49 years were the ones with the largest participation for males (n = 257) and females (n = 94). Figure 1 shows the number of finishers according to sex and age group. There were 1,843 finishers (95.3%), including 1,399 men (95.0%) and 444 women (96.3%). Across different age groups, the numbers of finishers ranged from 4 to 241 in males and from 3 to 90 in females. Men accounted, on average, for 81.7 ± 10.4% (from 70.7 to 100.0%) of finishers in the age groups, whereas women constituted 18.3 ± 10.4% (from 0.0 to 29.3%) of finishers in the age groups.

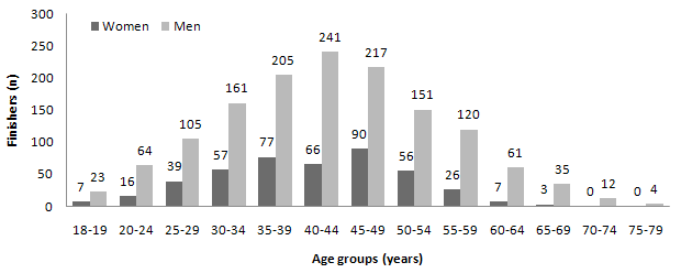

Figure 1. Number of finishers according to sex and age group at the Triathlon Cross World Championships from 2011 to 2016

Table 1 shows the performance times (minutes) for swimming, cycling, running, and total race for the top 10 male and female triathletes in each age group at the Cross Triathlon World Championships. As already mentioned, due to the limited

Table 1. Performance times (minutes) in swimming, cycling, running, and total race for the top 10 male and female triathletes in each age group at the Triathlon Cross World Championships

	Men					Women				
Age	*n*	Swimming	Cycling	Running	Total race	*n*	Swimming	Cycling	Running	Total race
25-29	59	21.0 (6.6)	88.0 (14.0)	43.0 (11.3)	154.4 (25.1)	37	23.6 (4.4)	113.1 (27.5)	49.5 (17.5)	189.5 (41.4)
30-34	60	20.3 (5.3)	85.2 (16.1)	41.7 (10.3)	149.4 (23.5)	49	25.2 (5.4)	111.3 (29.5)	50.7 (13.9)	190.3 (38.9)
35-39	59	20.5 (4.7)	88.6 (16.6)	42.7 (12.3)	154.5 (26.3)	49	23.1 (5.9)	112.2 (18.3)	50.2 (12.9)	189.0 (26.5)
40-44	60	20.2 (4.9)	86.7 (17.2)	41.3 (9.8)	150.8 (24.0)	55	24.8 (6.9)	115.9 (29.0)	54.3 (12.7)	198.5 (36.2)
45-49	60	20.8 (5.4)	88.9 (16.7)	42.6 (9.9)	154.9 (23.2)	58	24.3 (6.0)	111.3 (20.5)	53.2 (12.3)	192.4 (25.6)
50-54	60	22.7 (5.8)	94.5 (17.5)	45.7 (11.3)	165.7 (25.3)	48	27.4 (5.1)	119.3 (26.4)	57.9 (17.3)	208.5 (37.4)
55-59	57	23.7 (5.8)	100.2 (18.7)	48.4 (9.7)	175.5 (22.4)	26	28.6 (6.0)	134.0 (36.5)	66.3 (18.0)	233.3 (46.1)
Total	415	21.3 (5.6)	90.2 (17.3)	43.6 (10.9)	157.8 (25.6)	322	25.1 (6.1)	115.5 (26.9)	53.9 (15.2)	198.0 (37.2)

Note. Values are reported as means (standard deviations).

number of triathletes in some age groups, analyses were performed for the age groups from 25-29 to 55-59 years. Men, on average, performed the triathlon race in 157.8 ± 25.6 min (149.4-175.7 min), swimming in 21.3 ± 5.6 min (20.2-23.7 min), cycling in 90.2 ± 17.3 min (85.2-100.2 min), and running in 43.6 ± 10.9 min (41.3-48.4 min). Women, on average, performed the triathlon race in 198.0 ± 37.2 min (189.0-233.3 min), swimming in 25.1 ± 6.1 min (23.1-28.6 min), cycling in 115.5 ± 26.9 min (111.3-134.0 min), and running in 53.9 ± 15.2 min (49.5-66.3 min).

Figure 2 presents the age-related changes in performance time (minutes) in swimming, cycling, running, and total race for the top 10 female and male triathletes at the Cross Triathlon World Championships. For both men and women, the mean age-related performance time in swimming, cycling, running, and total race was approximately flat from the age groups of 25-29 to 45-49 years, and then for the age groups of 50-54 and 55-59 years, it increased drastically along a straight line. The results of the two-way ANOVAs on the average performance time obtained at the Cross Triathlon World Championships (swimming, cycling, running, and total race) did not show a statistically sig-

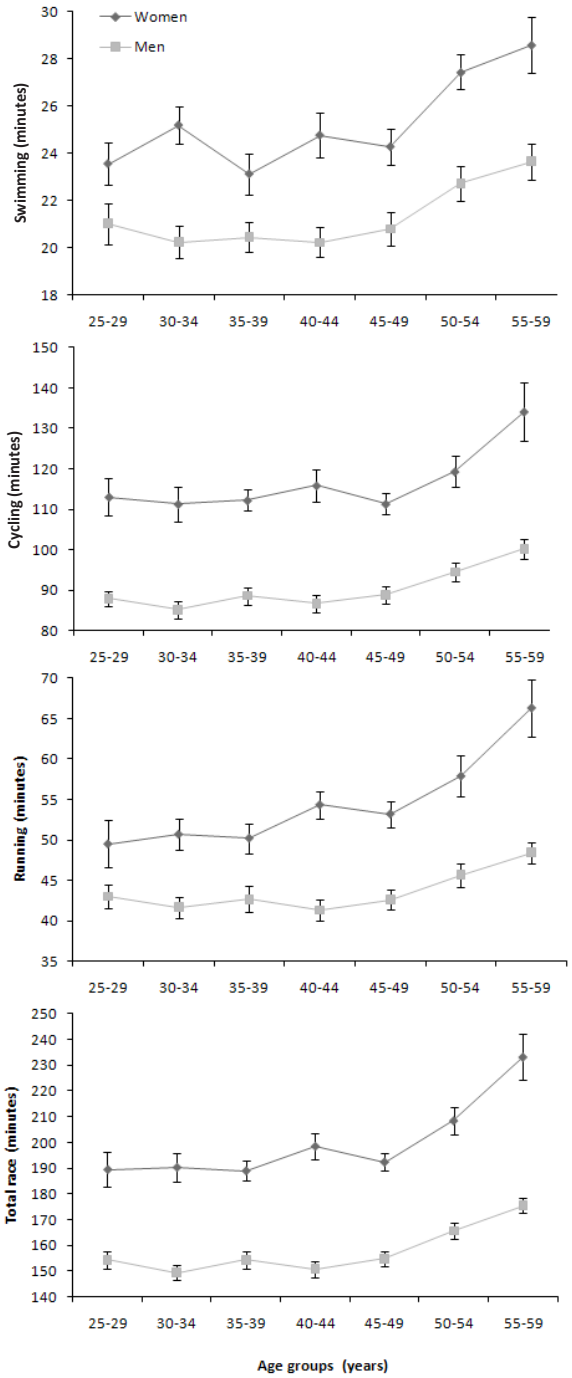

Figure 2. Sex differences and age-related changes in the top 10 triathletes in performance time (minutes) in swimming, cycling, running and total race at the Cross Triathlon World Championships (mean ± standard error)

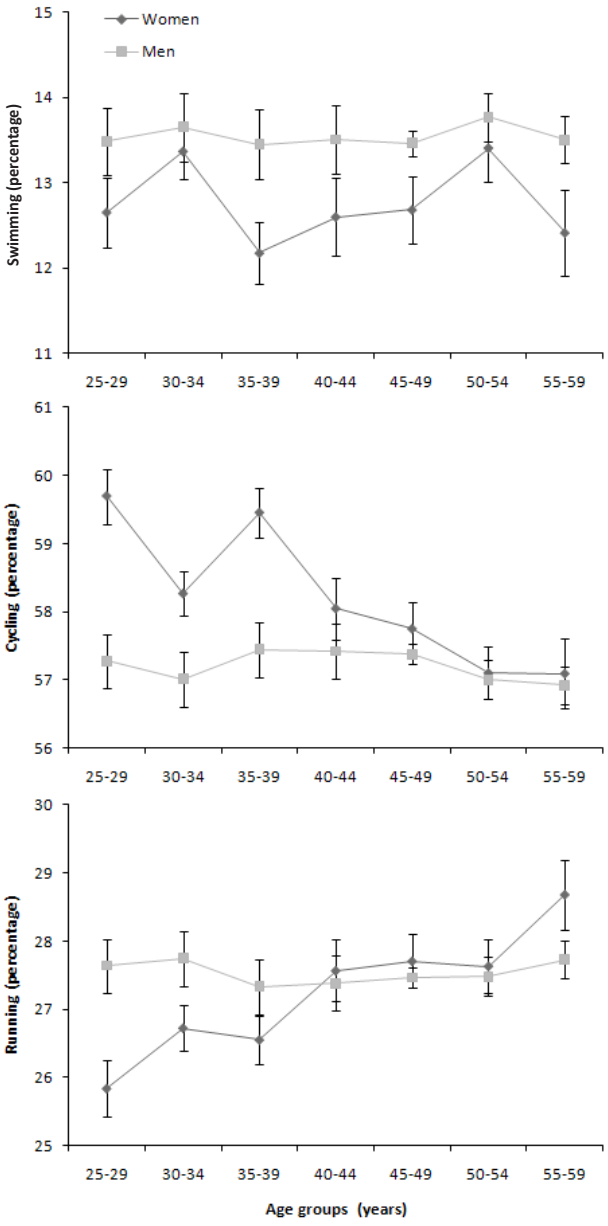

Figure 3. Sex differences and age-related changes in the top 10 triathletes in relative performance (percentage of the total race time) in swimming, cycling, and running at the Cross Triathlon World Championships (mean ± standard error)

nificant interaction effect between sex and age group ($p > 0.05$), indicating that both sexes showed a similar pattern. However, overall statistically significant differences were found between both the sex and age categories analysed separately (swimming, cycling, running, and total race; $p < 0.001$). Subsequently, the post-hoc pairwise comparisons with the Bonferroni adjustment showed that, on average, men had statistically significantly better performance (in swimming, cycling, running, and total time) than women in all age categories ($p < 0.05$). Regarding the age group analyses, the pairwise comparisons with the Bonferroni adjustment revealed that for male triathletes, the best time was found in the age group of 40-44 years for swimming and running and in that of 30-34 years for cycling and total race, but the differences in performance times observed between these age groups and the other age categories were not statistically significant ($p > 0.05$), except with respect to the age group of 55-59 years ($p < 0.05$). For female triathletes, the best time for swimming and total race and was obtained in the age group of 35-39 years and for running in the group of 25-29, but the differences in performance times between this age group and the other age categories were not statistically significant ($p > 0.05$), apart from the 50-54 and 55-59 age groups ($p < 0.05$). For cycling, the best time in female triathletes was noted in the age group of 30-34 years, but again the differences in performance times between this age group and the other age categories were not statistically significant ($p > 0.05$), except when it came to persons aged 55-59 years ($p < 0.05$).

Figure 3 presents the effect of age-related changes on relative performance in the top 10 female and male triathletes (percentage of total race time) in swimming, cycling, and running at the Cross Triathlon World Championships. The results of the two-way ANOVAs on the average percentage of the total race time at the Cross Triathlon World Championships (swimming, cycling, and running) did not show a statistically significant interaction effect between sex and age group ($p > 0.05$), indicating that both sexes had a similar pattern. Additionally, no overall statistically significant differences between sex and age categories considered separately (swimming, cycling, and running) were found ($p > 0.05$), except for swimming and cycling in the sex categories ($p < 0.05$). However, the subsequent post-hoc pairwise comparisons with the Bonferroni adjustment showed that male and female triathletes had a similar relative performance in swimming and cycling in all the age groups ($p > 0.05$), except for swimming in the 35-39 age group and cycling in the age groups of 25-29 and 35-39 years ($p < 0.05$).

Figure 4 illustrates the age-related changes in the performance ratios in swimming, cycling, running, and total race in the top female and male 10 triathletes at the Cross Triathlon World Championships. For both men and women, the mean age-related performance ratio in swimming, cycling, running, and total race decreased in a curvilinear manner with advancing age. The results of the two-way ANOVAs on the average performance ratio at the Cross Triathlon World Championships (swimming, cycling, running, and total race) did not show a statistically significant interaction effect between sex and age group ($p > 0.05$), indicating that both sexes had a similar pattern. Additionally, no overall statistically significant differences between the two sexes (swimming, cycling, running, and total race) were observed ($p > 0.05$). On the other hand, overall statistically significant differences between age categories were found (swimming, cycling, running, and total race) ($p < 0.001$). The post-hoc pairwise comparisons with the Bonferroni adjustment showed that for male triathletes, the best time for running was achieved in the age group of 40-44 years, but no statistically significant differences in performance times were observed between this age group and the other age categories ($p > 0.05$), except for the age group of 55-59 years ($p < 0.05$). When it comes to cycling and total race times, for male triathletes, the best time was obtained in the age group of 30-34 years, but the differences in performance times between these age groups and the other age catego-

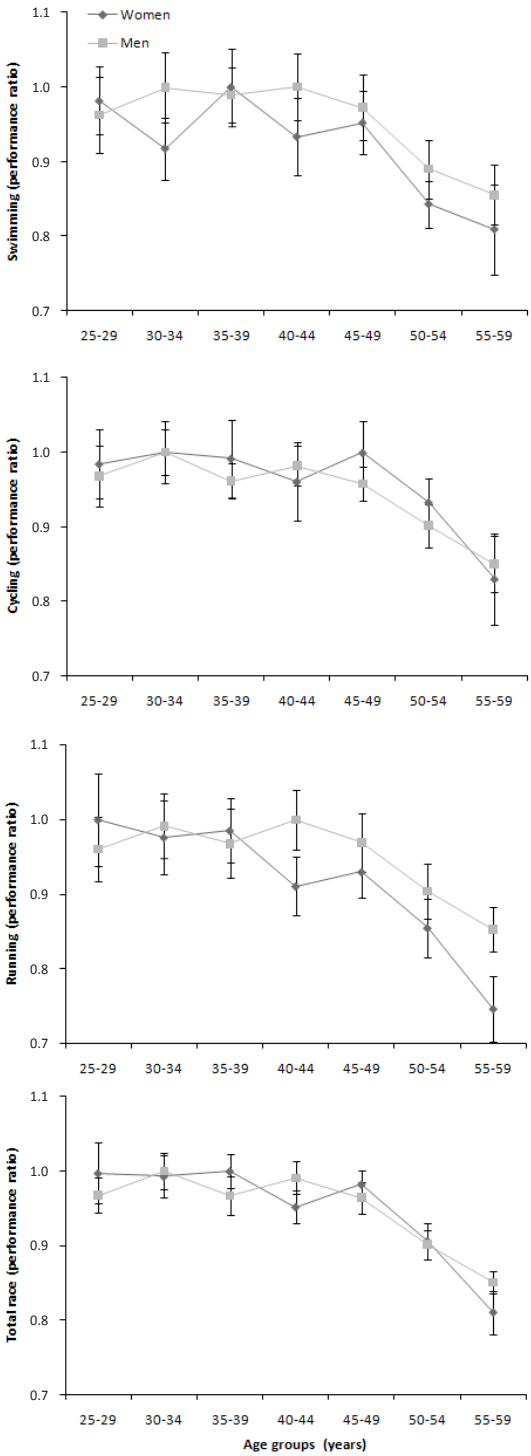

Figure 4. Sex differences and age-related changes in the top 10 triathletes in performance ratio in swimming, cycling, running and total race at the Cross Triathlon World Championships (mean ± standard error)

ries were not statistically significant ($p > 0.05$), apart from the 50-54 and 55-59 age groups ($p < 0.05$). In swimming, in male triathletes, however, statistically significant differences in performance times were not detected ($p > 0.05$). Regarding female triathletes, the best time was achieved in the 30-34 age group for cycling, in the 25-29 group for running, and in the 35-39 group for total race, but the differences in performance times between these age groups and the other age categories were not statistically significant ($p > 0.05$), except in the case of the 55-59 age group ($p < 0.05$). For swimming, in female triathletes, the best time was recorded in the 35-39 age group, but the differences in performance times between these age groups and the other age categories were not statistically significant ($p > 0.05$), apart from the 50-54 age group ($p < 0.05$).

Discussion

Participation trends

Participation levels across the age groups increased by 10% between the 2011 competition and the most recent competition analysed the study, that is the 2016 championships. Male representation fell, and there was notable growth in the female category, where participation rates doubled from 2011, reaching 103.3% in 2016.

The average finish rates (total: 95.3%; men: 81.7 ± 10.4%; women: 18.3 ± 10.4%) in our study can be viewed as similar to those reported in the study by Lepers et al. [8] on the Xterra World Championship Off-Road Triathlon in 2009 (total: 97.4%; men: 69%; women: 31%).

The age groups with the highest levels of participation were persons aged 40-44 and 45-49 years in men and women, respectively.

Other studies analysing the participation of triathletes have yielded heterogeneous results. Studies on the Ironman-distance triathlon have suggested that the level of participation of groups over 40 years of age in 2010 was 56% and 47% in men and women, respectively [15], or that the groups with the highest level of participation were 35- to 39-year-old male triathletes and 30- to 34-year-old female triathletes [1, 16].

The trends that stand out according to our findings and those referred to above are the high level of participation of master athletes aged over 40 and the increase in female participation across all age groups.

Differences in performance at different legs according to gender and age group

Although there are no significant differences in the average performance of the top 10 triathletes in the age groups spanning 25 to 49 years, in men, the best results in cycling and total race time were obtained in the 30-34 age group and in swimming and running between 40 and 44 years. Women obtained the best results in running at the age of 25-29, in cycling at 30-34, and in swimming and total race time at 35-39.

With regards to performance across the different age groups at the Cross Triathlon World Championship, in men and women, a high level of performance was maintained between 25 and 49 years, but it decreased significantly starting from the age of 50-54. These results are also partially consistent with those of Lepers et al. [8], who found a significant decrease in performance from the age of 55-59 years.

Studies conducted on the sports disciplines making up the cross triathlon legs (swimming, cycling, and running) have yielded results similar to those reported in our study. Swimmers of both sexes saw a linear decrease in their swimming performance from peak levels at age 35-40 years until approximately 70 years of age, after which performance declined exponentially [17].

In athletic running and cycling, peak endurance performance is maintained until the age of 30 to 35 years, followed by a moderate decrease until the age of 50 to 60 years [14, 18-20]. For distances of 100 km in ultramarathon running, no significant difference in race time was observed between the 30-34 and 45-49 age groups for males or for the five age groups between 30-34 and 50-54 years for females [21].

Conclusions

The age groups with the highest level of participation in the Cross Triathlon World Championship between 2011 and 2016 were 40-44 and 45-49 in men and women, respectively. There was a notably significant increase in female participation across all age groups. The results confirm that there is a demand for practising sports among persons aged 40+.

When it comes to performance in the different age groups, in men and women, it was maintained at a high level between 25 and 49 years, but it decreased significantly starting from the age of 50-54.

Although there were no significant differences in performance up to 49 years of age, in men, the best results in cycling and total race time were obtained between 30 and 34, and the best outcomes in swimming and running were recorded for persons aged 40-44 years.

Women obtained the best results in running in the 25-29 age group, in cycling in the 30-34 group, and in swimming and total race time in the 35-39 group.

Based on the findings of the study, it can be suggested that the sports training of these triathletes should be aimed at obtaining the best results between 30 and 35 years.

Limitations

Due to the lack of publications on the cross triathlon, and specifically on performance across age groups, publications focusing on elite and conventional triathlons, in addition to sports disciplines making up the cross triathlon legs (swimming, cycling, and running), needed to be referred to in the discussion in this article.

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