Open Access Journal of Sports Medicine

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ORIGINAL RESEARCH

The age of peak performance in women and men duathletes – The paradigm of short and long versions in "Powerman Zofingen"

This article was published in the following Dove Press journal:
Open Access Journal of Sports Medicine

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Purpose: The age of peak performance (APP) has been studied extensively in various endurance and ultra-endurance sports; however, less information exists in regard to duathlon (ie, Run1, Bike, and Run2). The aim of the present study was to assess the APP of duathletes competing either in a short (ie, 10 km Run1, 50 km Bike, and 5 km Run2) or a long distance (ie, 10 km Run1, 150 km Bike, and 30 km Run2) race.

Participants and methods: We analyzed 6,671 participants (women, n=1,037, age 36.6±9.1 years; men, n=5,634, 40.0±10.0 years) in "Powerman Zofingen" from 2003 to 2017.

Results: Considering the finishers in 5-year age groups, in the short distance, a small main effect of sex on race time was observed ($p<0.001$, $\eta^2=0.052$) with men (171.7±20.9 min) being faster than women (186.0±21.5 min) by –7.7%. A small main effect of age group on race was shown ($p<0.001$, $\eta^2=0.049$) with 20–24 years being the fastest and 70–74 years the slowest. No sex × age group interaction was found ($p=0.314$, $\eta^2=0.003$). In the long distance, a small main effect of sex on race time was observed ($p<0.001$, $\eta^2=0.021$) with men (502.8±56.8 min) being faster than women (544.3±62.8 min) by –7.6%. A large main effect of age group on race time was shown ($p<0.001$, $\eta^2=0.138$) with age group 25–29 years the fastest and age group 70–74 years the slowest. A small sex × age group interaction on race time was found ($p<0.001$, $\eta^2=0.013$) with sex difference ranging from –22.4% (15–19 age group) to –6.6% (30–34 age group).

Conclusion: Based on these findings, it was concluded an older APP in the long than in the short distance was seen in "Powerman Zofingen." This indicates that APP in duathlon follows a similar trend as in endurance and ultra-endurance running and triathlon, ie, the longer the distance, the older the APP.

Keywords: aging, cycling, master athletes, running, ultra-endurance

Introduction

The age of peak performance (APP) in various sports is used by sport scientists and gerontologists to study the master athlete as a model of healthy aging.[1] In this context, studies on endurance sports provide information about the rate that the decline in aerobic capacity with aging can be attenuated by chronic exercise.[2]

Run and bike are two major modes of aerobic exercise, which are more easily accessible compared to other modes of physical activity (eg, swimming, skiing, and rowing) demanding more sophisticated equipment, special venues, particular geography, and environmental conditions. The paradigm of duathlon, a sport combining run and bike,[3] can assist to examine the APP in a sport combining two different modes of aerobic exercise.

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Duathlon has been the subject of scientific research during the last two decades, especially in regard to medical issues[4] and nutritional[5] and physiological aspects.[6] In regard to their physiological profile, like athletes of other endurance sports, duathletes are characterized by high aerobic capacity, which in turn correlates with sport performance.[3]

Despite our improved knowledge about the physiological demands of duathlon based on the abovementioned studies, little information exists in regard to the APP in this sport. A recent study investigated APP in the "Powerman Zofingen" long-distance duathlon (10 km run, 150 km cycle, and 30 km run) and reported that the fastest overall race times were achieved between the 25- and 39-year-old atheletes.[7] Research on triathlon indicated that APP might vary by distance, with shorter formats of triathlon showing younger APP and vice versa.[8]

Nevertheless, it is not known whether the APP varies between the different formats of the "Powerman Zofingen" duathlon, ie, a short versus a long-distance race. Both duathlon and triathlon are multisports including running and cycling, but in contrast to duathlon, triathlon includes swimming as well. It has been proposed that the age-related decrease in aerobic capacity is specific to the mode of locomotion, with smaller decrease observed in cycling than in running.[2,9] Since duathlon differed for its modes of lomotion from triathlon, it would be reasonable to assume that the APP would also differ. Therefore, the main aim of the present study was to examine APP in short and long-distance duathlon (ie, total race time). The research hypothesis was that APP would be older in the long than in the short distance considering the relevant findings on other multisports.[8]

Participants and methods

The race

The "Powerman Zofingen" is a duathlon event held in Zofingen (Switzerland) within the "Powerman World Series." In this race, a short- and a long-distance versions are held. The long distance race of "Powerman Zofingen" has been held for years as the official Powerman World Championships under the name of "ITU Powerman Long Distance Duathlon World Championships."

A duathlon consists of a running part, a cycling part, and then again, a running part, which are carried out one directly after another. Since 2002, the long distance race of "Powerman Zofingen" has the sequence of 10 km running, 150 km cycling, and 30 km running. At the same time, similar to the long distance race, also a short distance is held covering 10 km running, 50 km cycling, and 5 km running. Before 2003, the race course and the distances of the split disciplines changed several times since the first edition of the race in 1989.

Methodology

Data were obtained from the official race website from "Powerman Zofingen" www.powerman.ch/de. Race results were sorted by name, age, and sex of the finishers separately for both the short- and the long-distance race. Athletes were classified in 5-year age groups from 15–19 years to 70–74 years.

Statistical analysis

Data are presented as mean ± SD. Chi-square test examined sex × distance association and sex × age group association within each distance. A two-way analysis of variance (ANOVA) examined the sex × distance interaction on age and race time. Within each distance, a two-way ANOVA examined the sex × age group interaction on race time. The magnitude of these interactions was examined using effect size partial eta square (η^2_p) and was evaluated as follows: small ($0.010 < \eta^2_p \leq 0.059$), moderate ($0.059 < \eta^2_p \leq 0.138$), and large ($\eta^2_p > 0.138$).[10] Statistical analyses were carried out using GraphPad Prism Version 7.0 (GraphPad Software, San Diego, CA, USA) and IBM SPSS Version 23.0 (SPSS, Chicago, IL, USA).

Ethical approval

The institutional review board of Kanton St. Gallen, Switzerland, approved all procedures used for the study with a waiver from the requirement for informed consent of the participants given the fact that the study involved the analysis of publicly available data. The study was conducted in accordance with recognized ethical standards according to the Declaration of Helsinki adopted in 1964 and revised in 2013.

Results

No sex × distance association was observed (χ^2=0.635, p=0.426, φ=0.010), with short and long distance presenting a similar men-to-women ratio (MWR; 5.30 and 5.59, respectively). This finding indicated that the proportional participation of sexes was similar for the two distances. In short distance, a sex × age group association was shown (χ^2=114.766, p<0.001, φ=0.181) with MWR ranging from 2.71 (20–24 age group) to 24.17 (55–59 age group) (Figure 1). Most women (n=108) were in the age group 30–34 years and the least (n=0) in age groups 60–64, 65–69, and 70–74 years. Most men (n=556) were in the age group 40–44 years, and the least (n=2) in the age group 70–74 years.

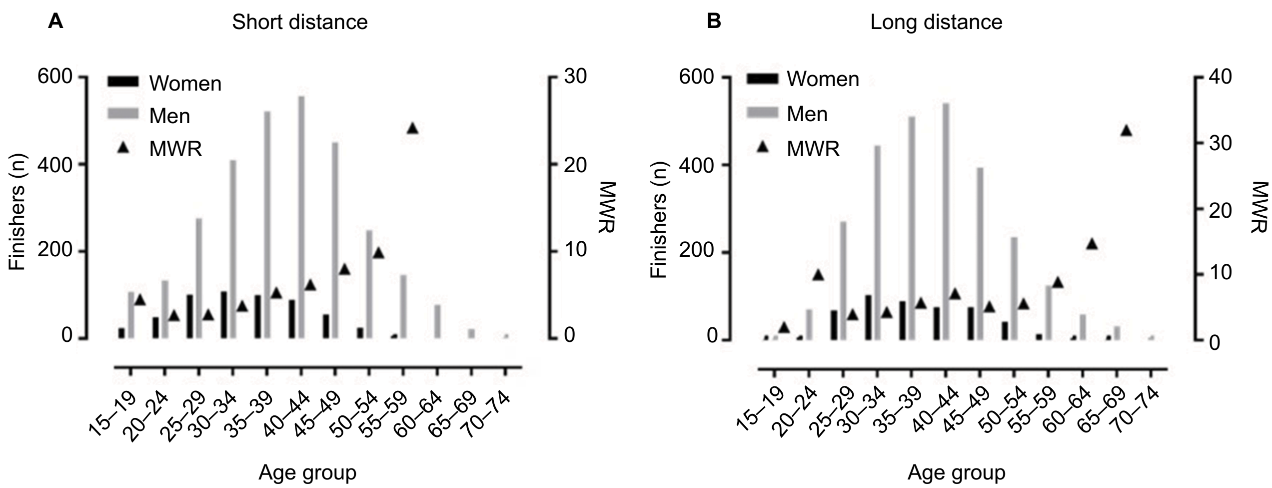

Figure 1 Finishers by sex and age group in short **(A)** and long distance **(B)**.
Abbreviation: MWR, men-to-women ratio.

In long distance, a sex × age group association was shown (χ^2=30.653, p=0.001, φ=0.098), with MWR ranging from 2.00 (age group 15–19 years) to 32.00 (age group 65–69 years). Most women (n=103) were in the age group 30–34 years and the least (n=0) in age group 70–74 years. Most men (n=541) were in age group 40–44 years and the least (n=6) in age group 70–74 years.

A trivial main effect of distance on age was observed (p<0.001, η^2=0.008), with finishers in the long distance being older than those in the short distance (40.2±9.4 versus 38.8±10.4 years, respectively). Also, a small main effect of sex on age was shown (p<0.001, η^2=0.014), with men being older than women (9.3%; 40.0±10.0 versus 36.6±9.1 years, respectively). A trivial sex × distance interaction on age was found (p<0.001, η^2=0.003), with sex difference in age being larger in the short than in the long distance (13.9% versus 4.3%, respectively).

Considering the finishers in 5-year age groups, in short distance, a small main effect of sex on race time was observed (p<0.001, η^2_p=0.052) with men (171.7±20.9 min) faster than women (186.0±21.5 min) by –7.7% (mean difference: –14.3 min; 95% CI: –16.2, –12.4) (Figure 2). A small main effect of age group on race was shown (p<0.001, η^2_p=0.049) with age group 20–24 years the fastest and age group 70–74 years the slowest. No sex × age group interaction was found (p=0.314, η^2_p=0.003). In long distance, a small main effect of sex on race time was observed (p<0.001, η^2_p=0.021) with men (502.8±56.8 min) being faster than women (544.3±62.8 min) by –7.6% (–41.5 min; 95% CI: –47.1, –35.9). A large main effect of age group on race time was shown (p<0.001, η^2_p=0.138) with age group 25–29 years being the fastest and age group 70–74 years the slowest. A small sex × age group interaction on race time was found (p<0.001, η^2_p=0.013) with sex difference ranging from –22.4% (age group 15–19 years) to –6.6% (age group 30–34 years). That is, the APP was older in the long (25–29 years) than in the short distance (20–24 years).

When the finishers were analyzed in 1-year age groups, the fastest race time was at 22 years and the slowest at 58 years in the short distance (Figure 3). In the long distance, the fastest race time was at 33 years and the slowest at 69 years. In both distances, a "U" shape relationship was observed between race time and age. It should be highlighted that the coefficient of determination between age and race time was stronger in the long than in the short distance. Also, independently from the use of either 5-year or 1-year age groups, we observed an older APP in the longer than in the shorter distance.

Discussion

The main findings of the present study were 1) no difference in the MWR (~5.5) between short and long distance and higher MWR in the older age groups; 2) in both distances, men were faster than women by ~8%; 3) considering the finishers in 5-year age groups, athletes in the age group 20–24 years were the fastest in short distance and athletes in the age group 25–29 years were the fastest in long distance, whereas athletes in the age group 70–74 years were the slowest in both distances; and 4) when the finishers were analyzed in 1-year age groups, the fastest race time was at 22 years and

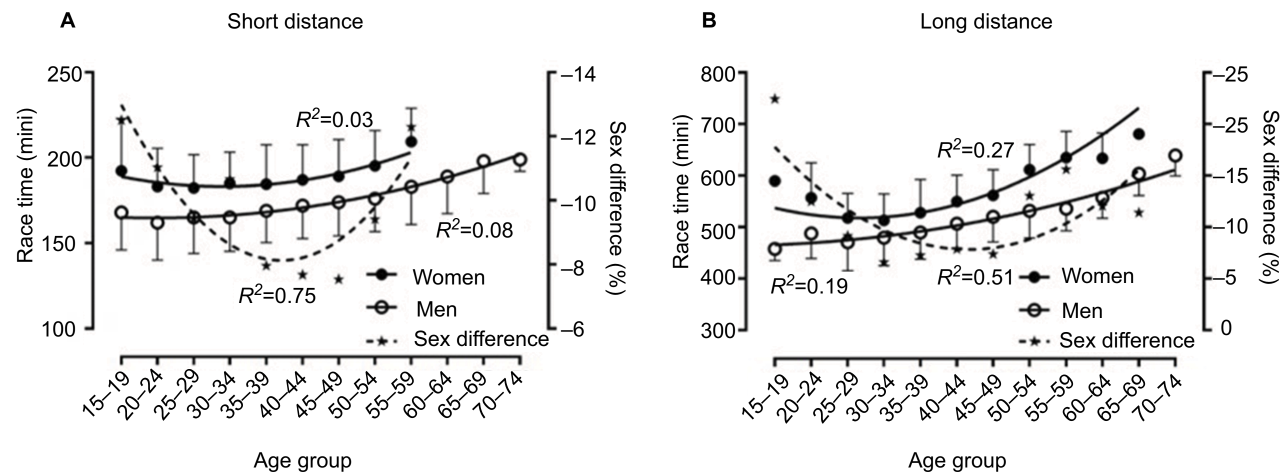

Figure 2 Race time and sex difference by 5-year age group in short **(A)** and long distance **(B)**.

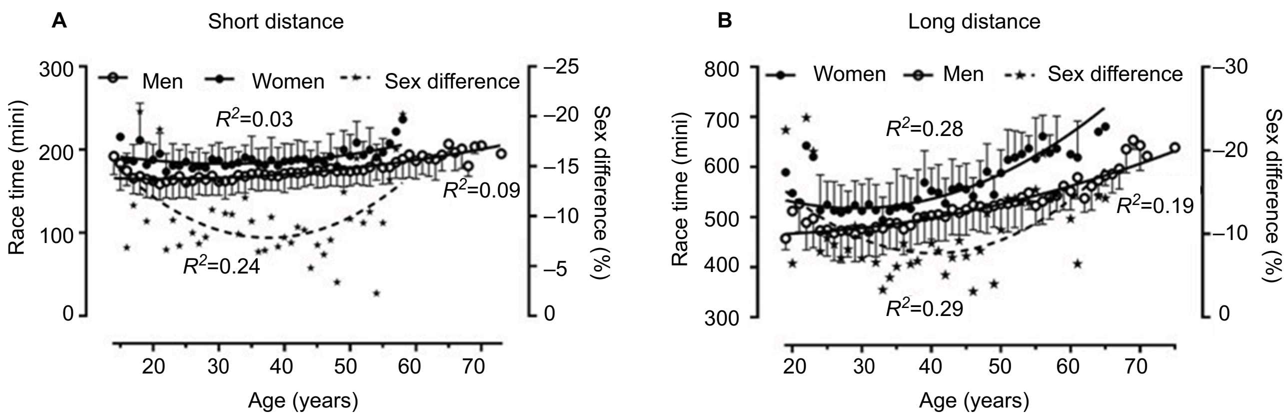

Figure 3 Race time and sex difference by 1-year age group in short **(A)** and long distance **(B)**.

the slowest at 58 years in the short distance, whereas in the long distance, the fastest race time was at 33 years and the slowest at 69 years.

In regard to participation trends, the similar MWR in both distances was in disagreement in ultra-endurance running, where recent research observed a MWR of 2.99 in 50 km[11] but 7.30 in 100 km ultra-marathon running,[12] indicating a higher participation of men in the longer ultra-marathons. This discrepancy might be due to differences by sport, according to which higher values of MWR are observed in triathlon (eg, 10.6 in the "Isklar Norseman Xtreme Triathlon"),[13] which has affinity to duathlon, compared to running events. The higher MWR in the older age groups was in agreement with other ultra-endurance events.[11,12] Considering the performance trends, the sex difference in the "Powerman" (~8%) lies between that observed in 50 km (11.9%)[11] and 100 km ultra-marathon running (5.4%).[12]

The main finding of the present study was that both methodological approaches (either using 5-year or 1-year age groups) indicated that the APP was younger in the short than in the long distance. This finding was in agreement previous observations that finishers and APP were younger in shorter distances of ultra-endurance exercise.[8,11,12] For instance, Knechtle et al[8] showed that the APP of the top 10 triathletes was younger in the Olympic than the Half-Ironman distance, which in turn was younger than the Ironman distance. The APP in "Powerman Zofingen" was younger than 50 km[11] and 100 km ultra-endurance running.[12] A previous study on the long distance of "Powerman Zofingen" showed that younger adults and men were faster than women and older adults, the APP was in age group 25–39 years, and the decline of running with aging was more pronounced than in cycling.[7] Moreover, the APP of the annual top 10 in Ironman triathlon was 32–33 years in both sexes.[14] An explanation of the older APP in the long distance of "Powerman Zofingen" compared to the short distance might be the corresponding difference in the age of finishers in each distance. The older age of athletes in longer ultra-endurance sports might be justified by the notion that ultra-endurance athletes need first to have finished shorter distances before participating in longer races.[15]

APP in "Powerman Zofingen" was close to the age of peak aerobic capacity. Duathletes have a high aerobic capacity, eg, maximal oxygen uptake (VO_2max) was ~67 $mL \cdot min^{-1} \cdot kg^{-1}$ in men of various performance levels.[3] VO_2max has been shown to relate with sport performance in duathlon, consisting of 32 km bike and 6.4 km run, as suggested by the very large correlation between VO_2max and race time.[3] Another study indicated maximum workload and maximum velocity as best predictors of duathlon performance.[16] Thus, the relationship between performance in duathlon and VO_2max explains that the APP is similar in both of them.

In regard to the variation of physiological demands during the race, previous research showed that in duathlon consisted of 5 km of running, 30 km of cycling, and 5 km of running; thus, there was a lack of significant difference in energy cost of running.[17] Moreover, in the 5 (Bike1)-20 (Run)-2.5 km (Bike2), heart rate in Bike1 and Bike2 was similar (~94% of the maximum heart rate).[18] These findings stressed the importance of aerobic capacity for performance in duathlon. The age-related decline in duathlon followed a similar pattern as that of VO_2max, which shows a decline of 0.2–0.5 $mL \cdot min^{-1} \cdot kg^{-1} \cdot year^{-1}$.[19] The decrease of VO_2max with aging might be due to reduced cardiac output and skeletal muscle oxidative capacity.[20]

A limitation of the present study was that it did not consider the variation in the environmental conditions (eg, temperature and humidity) that may impact on performance. It has been shown that duathlon performance (5-30-5 km) was faster and that fat oxidation, core temperature, and postexercise prolactin were lower at 10ºC than at 30ºC.[21] Furthermore, the effect of technical equipment (eg, bike, shoes, clothing) and nutrition may influence duathlon performance, but it was not controlled.[22] It should also be highlighted that the term "finishers" used in the present study referred to finishes rather than to individual duathletes, ie, a duathletes might have finished in several "Powerman Zofingen" across calendar years. On the other hand, the present study was the first to be conducted on short distance "Powerman Zofingen," and knowledge about APP would be useful for coaches and athletes in this sport. For instance, coaches could apply this knowledge in order to set long-term training goals for their athletes. Moreover, sports physiologists interesting in the decline of aerobic capacity with aging could use the findings of the present study in regard to the modes of locomotion used in duathlon.

Conclusion

Based on these findings, it was concluded that there is an older APP in the long than in the short distance of Powerman Zofingen. This indicates that APP in duathlon follows a similar trend as in endurance and ultra-endurance running, ie, the longer the distance, the older the APP.

Disclosure

The authors report no conflicts of interest in this work.

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