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No gender difference in peak performance in ultra-endurance swimming performance - analysis of the 'Zurich 12-h Swim' from 1996 to 2010

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Publikationshinweis

No Gender Difference in Peak Performance in Ultra-Endurance Swimming Performance — Analysis of the 'Zurich 12-h Swim' from 1996 to 2010

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Abstract

The aims of the study were to [1] investigate the performance trends at the 'Zurich 12-h Swim' in Switzerland from 1996 to 2010; and [2] determine the gender difference in peak performance in ultraendurance swimming. In total, 113 male and 53 female swimmers competed in this indoor ultraendurance event while swimming in a heated pool. The number of male participants significantly increased ($r2 = 0.36$, $P = 0.04$) over time while the participation of females remained unchanged ($r2 = 0.12$, $P = 0.26$). In the age group < 19 years, the male swimmers achieved a significantly greater distance than the females (32.7 km vs. 21.9 km, respectively) ($P < 0.05$). In the older age groups (20-29 years, 30-39 years, 40-49 years, and 50-59 years, respectively) was no gender difference in swimming performances ($P > 0.05$). The best performance was achieved in the age groups 30-39 years and 40-49 years for both genders, respectively. The athletes in the age groups < 19 years, 20-29 years and 50-59 years in females were significantly slower than the athletes in the age group 30-39 years and 40-49 years ($P < 0.05$). For the males, the athletes in the age group 30-39 years were significantly faster than the athletes in the age group < 19 years. The annual best performance was not significantly different between males and females (38.3 ± 2.9 km vs. 34.4 ± 8.2 km, respectively) ($P > 0.05$). The best male and female swim performances remained unchanged across the years. Females are able to achieve a similar swim performance in an indoor ultra-endurance swim event of ~40 km. Further studies are needed to investigate whether females are able to achieve similar or even better performances than males in openwater ultra-swimming events such as 'Channel Swimming'.

Key words: master athletes – endurance – indoor swimming – male – master athletes

Introduction

Over the last decade, the popularity of ultraendurance events such as ultra-running (5, 12, 25), ultraswimming (10, 8, 30) and ultra-triathlon (11, 14) has increased. There was a trend in increased participation after the first races for both ultra-running (5) and ultra-triathlon (14). However, data regarding performance in ultra-swimming (10, 8, 30) are scarce. Previous studies on ultra-swimming have investigated a potential association between both physiological and anthropometric characteristics and performance (7, 8, 20, 29). Knechtle et al. (10) investigated the association between anthropometric characteristics and the achieved kilometers in male swimmers in a 12-h indoor swimming event. Tanaka and Seals (27) described age-related changes in swimming performance in master athletes, who are typically older than 35 years of age (22), compared with younger swimmers. VanHeest et al. (29) analysed the metabolic and physical characteristics of a group of elite open-water swimmers. Besides physiological (29) and anthropometrical characteristics (4, 8-10), age (12, 17, 18) and gender (12, 14, 15) seem to influence ultra-endurance performance. When swimming performances of females and males in different strokes (e.g., freestyle,butterfly, breaststroke, backstroke, and different distances such as 50, 100, 200, 400, 800, and 1,500 m) were examined at the Olympic Games in 2000, females were 11% slower than males (28). Similar findings were obtained using 'Ironman Hawaii' triathlon data where the gender difference was close to 9-10% over the 3.8 km swim split (14). Tanaka and Seals (26) reported that the gender differences decreased with increasing swimming distance in freestyle swimming in the US Master Championship. For distances longer than 1,500 m, the opposite was found. In 36 km swimming (i.e., Deca Iron ultra-triathlon), the male athletes where ~45% faster compared to females (11). The faster swimming times for males might be explained by gender differences in anthropometry, physiology and energy expenditure (26). However,

gender differences in ultra-endurance swimming in ultra-swimmers, not ultra-triathletes, have not yet been examined. The anthropometry of females (e.g., higher percent body fat and higher buoyancy) could be advantageous in longer swim distances, which may reduce gender differences since female athletes typically have more body fat than males (8, 21) which increases buoyancy (21).

Regarding age-related swimming performances, the best age for competing in swimming is probably between 30-35 years for females and 25-40 years for males (26). In addition, masters swimming athletes were able to compete at a high level of intensity when they have strong stroke mechanics and achieve minimal drag (21). Nevertheless, a decrease in swimming performance occurred between the age of 35-40 years in both genders, and the performance decline increased exponentially after 70 years of age in both males and females (1, 26).

To date, no study has investigated the participation and performance as well as any gender differences in ultra-endurance swimmers. The 'Zurich 12-h Swim' in Switzerland is of interest because data exist from 16 years of competition from 1996 to 2010. In total, 113 male and 53 female ultra-endurance swimmers competed in this event, where the participants have to complete as many kilometers as possible over 12 h in a heated indoor pool. Ultra-endurance swimmers from all over the world compete in this event as a prerace preparation to cross the English Channel from Dover to Calais. Therefore, the aims of the study were to [1] investigate the performance trends at 'Zurich 12-h Swim' from 1996 to 2010; and [2] determine the gender difference in peak performance in ultra-endurance swimming. According to previous literature, we hypothesized that the age of peak performance would be between 30 to 35 years for females and 25 and 40 years for males.

Materials and Methods

Subjects

The age of each competitor as well as the total swim distance achieved were analyzed for all finishers in the 'Zurich 12-h Swim' in Switzerland from 1996 to 2010. The data set for this study was obtained from the race website of 'Sri Chinmoy Marathon Team Switzerland' (http://ch.srichinmoyraces.org/veranstaltungen/12_stunden_schwimmen). The study was approved by the institutional review board of St.Gallen, Switzerland, with a waiver of the requirement for informed consent given that the study involved the analysis of publicly available data.

The 'Zurich 12-h Swim' takes place in a 50 meter indoor pool in Zurich, Switzerland, constantly heated to ~28°C water temperature. The event starts at 8 a.m. and the athletes are given 12 h till 8 p.m. to complete as many kilometers as possible. Each athlete has a personal lap counter. The swimmers are neither allowed to swim in a high-tech swimsuit nor to use additional equipment such as fins, boards or pool buoys. The swimmers are allowed to take as many breaks as they like. Nutrition such as rice, pasta, snacks, fruits, sweets and drinks is offered by the organizer and is taken ad libitum. For the analysis, all swimmers who had participated in the 'Zurich 12-h Swim' between 1996 and 2010 were included. In 1997, 1999, 2002 and 2011, no race was held, so data were available from 12 years and for 166 athletes in total. From these 166 athletes, data for total participation, performance, and trends by gender as well as age could be obtained to analyze the development of performance by gender. Every year, the athlete with the best performance, expressed as the greatest swim distance achieved within 12 h, was investigated for both males and females.

To investigate age-related changes in performance or participation, all athletes were categorized by age groups as follows: < 19 years, 20-29 years, 30-39 years, 40-49 years, 50-

59 years, 60 years and above. In order to determine the age group of the best performance, all male and female swimmers competing in the same age group were pooled and subsequently ranked by performance. From the top 5 performances by gender and age group, the mean performance as well as standard deviation were calculated and compared. The mean values of the top 5 performances by age group and gender were calculated.

Statistical analysis

To test significant differences in the development of a variable across the years, linear regression analyses were used. A Student's t-test was used to find differences in case of two groups (male-female) and one-way ANOVA with subsequent Tukey-Kramer post-hoc analysis in case of more than two groups (age groups). Statistical analyses were performed with IBM SPSS Statistics (Version 19, IBM SPSS, Chicago, IL, USA) and GraphPad Prism (Version 5, GraphPad Software, La Jolla, CA, USA). Significance was accepted at $P < 0.05$ (two-tailed for t-tests).

Results

Male and Female Participation and Performance

In total, 53 females and 113 males completed the 'Zurich 12-h Swim' successfully leading to a mean participation per event of 4 ± 2 female swimmers and 9 ± 4 male swimmers, respectively. The number of participants increased significantly for males ($r^2 = 0.35$; $P = 0.04$), but remained unchanged for females (see Fig. 1). The annual best performance was not significantly different between males and females (38.3 ± 2.9 km vs. 34.4 ± 8.2 km, respectively) ($P > 0.05$) (see Fig. 2). The best male and female swimming performances remained unchanged across the years ($P > 0.05$). The mean performance in females was not significantly different from that of males (27.2 ± 7.7km vs. 27.5 ± 7.8 km, respectively) ($P > 0.05$).

Change in Participation and Performance with Advancing Age

The number of participants per age group and year was low, thus no analysis regarding the development of performance by age group and gender was performed. Fig. 3 shows the number of participants per age group for females in panel A and for males in panel B. In females, the age group 40-49 years showed a significant increase in the number of participants ($r^2 = 0.46$; $P = 0.02$) whereas all other female age groups as well as all male age groups remained unchanged. In females, no athlete participated in the age group of 60 years and above.

The Age of Best Performance

Due to the low number of athletes per age group, not enough data were available for analysis in every age group. In females, data were available for all age groups between < 19 years and 50-59 years. In males, data were available for all age groups between < 19 years and 40-49

years. Fig. 4 shows the mean performance of the top 5 athletes per age group and gender for both males and females. For females, the fastest age group, 30-39 years, achieved a significantly ($P < 0.05$) greater distance of 41.3 ± 3.4 km compared to the age groups < 19 years, 20-29 years and 50-59 years ($P < 0.05$). However, athletes in this age group were not faster than athletes in the age group 40-49 years who completed a mean distance of 36.4 ± 4.3 km ($P > 0.05$). For males, the fastest swimmers were between 30-39 years of age and they swam a mean distance of 39.8 ± 1.7 km which was significantly greater for the swimmers in the age group < 19 years ($P < 0.05$). The performance of swimmers in the other male age groups was not significantly different from the best age group ($P > 0.05$). When young males and females (< 19 years) were compared, females had a mean performance distance that was significantly less than that of males in the corresponding age group (21.9 ± 10.0 km vs. 32.7 ± 4.9 km, respectively) ($P < 0.05$).

Discussion

The main findings in the present study were that [1] the annual best performance was not different between males and females and [2] the greatest swim distance was achieved in the age group 30-39 years for both females and males.

Male and Female Participation and Performance

The male swimmers increased their participation during 1996-2010 whereas the female participation remained unchanged. This coincides with the data from 'English Channel Swimming' where the male swimmers also increased their participation compared to females (www.dover.uk.com/channelswimming/swims). Males have a higher ego orientation than females (3) and participation of male swimmers may have increased because an ultra-swimming event such as the 'Zurich 12-h Swim' is an individual challenge and event. Nevertheless, the tendency for participation in other non-swimming ultra-endurance challenges is that female athletes increase their participation rate. For example, in the 161-km ultra-marathons in the USA, females represented 20% of the starting field in 2004 (5) and 27% in the 'Ironman Hawaii' in 2007 (14).

In the present study, the best performance per year did not differ by gender with 38.3 km for males and 34.4 km for females, respectively. This finding suggests that the best female swimmers in the 'Zurich 12-h Swim' were able to achieve a similar performance compared to male swimmers. In contrast to our hypothesis, the gender difference in indoor ultra-swimming appears similar to those observed for shorter swimming distances (14, 28). These differences may be due to a number of factors. A number of previous studies showed a correlation between swimming performance and both physiological and anthropometrical characteristics (8, 10, 29). For example, Knechtle et al. (8) reported that in male open-water ultra-swimmers

specific anthropometric characteristics (e.g., body height, body mass index, and length of arm) were associated with race time whereas in females, no correlation between race time and anthropometric factors were shown. In contrast, in a 12-h ultra-endurance swimming event, anthropometric characteristics were not related to race performance in male ultra-swimmers (10).

Tanaka et al. (26) compared the performance of the swimming distance of 50 m and 1,500 m and showed that in masters swimmers the gender difference was greater in short distance swimming than in long distance swimming. An explanation for the gender gap could be the difference in physiology and anthropometry between females and males. Male endurance athletes have only ~13-16% body fat whereas female athletes reach ~22-26% (8, 19). Athletes with more body fat may be more resistant to exhaustion (9) and the buoyancy increases (16, 21). Also, female swimmers may be able to achieve more mechanical efficiency compared with their male counterparts (13). Knechtle et al. (8) reported in their study on ultraendurance open-water swimmers that different anthropometrical aspects in female and male swimmers correlated to race performance. Body mass, body height, speed during training, and the length of arms were related to performance in males whereas swimming speed during training correlated to race performance in females (8). All these aspects might be advantageous for the performance of females in longdistance swimming and therefore reduce the gap in gender difference as observed in the current study.

Change in Participation and Performance with Advancing Age

In the present study, female athletes in the age group 40-49 years showed an increase in participation over time while the age groups for males showed no changes. A reason why female participation in the 40-49 years age group increased might arise from the fact that females in a normal population have a higher life expectancy and therefore live longer (24).

With the increasing age of the population (24), the age of females who enter menopause has also increased (2). Also, the family focus decreases as children leave home. Another reason why more females between 40-49 years compete in ultra-endurance swimming is that swimming causes fewer injuries than running or cycling (21); therefore a swimmer can remain competitive for a longer time. With increasing age, body fat increases, which may increase buoyancy (21) and serve as an advantage for long-distance swimming.

In the current study, the fastest swimmers, male or female, were 30-39 years old. Athletes between 40-49 years showed similar achievements as athletes between 30-39 years in both genders. This coincided with the findings of Tanaka and Seals (26) who showed that the best age of competing for swimmers was between 25 and 40 years for males and between 30 and 35 years for females. In contrast, the optimal swimming age in Olympians from the world-leading countries was 21.7 years for females and 23.2 years for males, respectively (6). A reason for this difference could be that the athletes in the study of Issurin et al. (6) were elite-swimmers and therefore trained professionally for a challenge whereas these ultra-endurance swimmers are recreational athletes. According to both Tanaka and Seals (26) and Rubin et al. (23), swimming performance started to decrease from the age of 35 years to the age of 60 years and the decline got more pronounced between the age of 60 and 85 years. Additionally, Tanaka and Seals (26) showed that the age-related decline was greater in female swimmers than in males.

The present results show male swimmers in the age group < 19 years were significantly faster than their female counterparts. One possible reason for the better swimming performances for young males could be that the female athlete, in contrast to the male athlete, has a low stroke volume which leads to a low cardiac output and lower blood volume which is important for circulation and oxygen delivery in muscles (19). Moreover, male athletes are muscularly

stronger than females because males have a higher androgen level and more skeletal muscle mass which are both essential for strength and power development (19). Furthermore, the oxygen-capacity for males is higher than for their female counterparts (19). Nevertheless, in the present study, only the male athletes younger than 19 years were faster than females; all other age groups did not differ significantly in their performance.

Over the period 1996-2010, male swimmers increased their participation in the 'Zurich 12-h Swim' in Switzerland while overall female participation showed no changes across the studied period, except in the 40-49 years age group. Athletes in the age group 30-39 years and 40-49 years achieved the fastest race performance in both genders. The maximum performance (kilometers swum) per year of competition for males and females were not significantly different. In contrast to pool swimmers across shorter distances (e.g., 1,500 m), where males are faster than females, it seems that female ultra-distance swimmers are able to achieve a similar swim performance in indoor ultraendurance swim events of ~40 km. Further studies are needed to investigate whether females are able to achieve similar or even better performances than males in open-water ultra-swimming events such as 'Channel Swimming'.

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Figure Captions

Figure 1

The number of male and female participants over the 1996-2010 period at the 'Zurich 12-h Swim'.

Figure 2

Maximum performance (= greatest swimming distance) by year for males and females at the 'Zurich 12-h Swim'.

Figure 3

Number of participants per age group for females in **Panel A** and for males in **Panel B** at the 'Zurich 12-h Swim'. In females, athletes in the age group 40-49 years — indicated by # — showed a significant increase in the number of participants ($P < 0.05$).

Figure 4

Mean performance of the top 5 athletes per age group and gender at the 'Zurich 12-h Swim'. # indicates age groups that are significantly ($P < 0.05$) different from the fastest one, which was 30-39 years for both, males and females. The fastest age groups are indicated by an arrow. $ indicates age groups with a significant ($P < 0.05$) different performance in males and females.

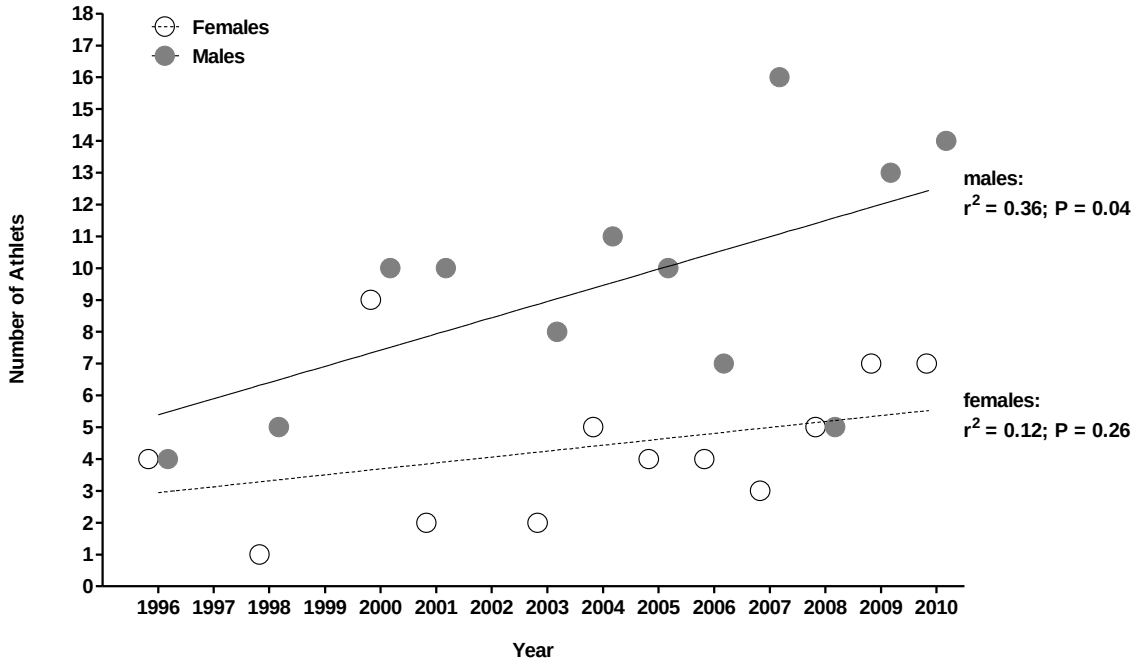

Females
Males
Number of Athlets
Year
males:
r2 = 0.36; P = 0.04
females:
r2 = 0.12; P = 0.26

Figure 1

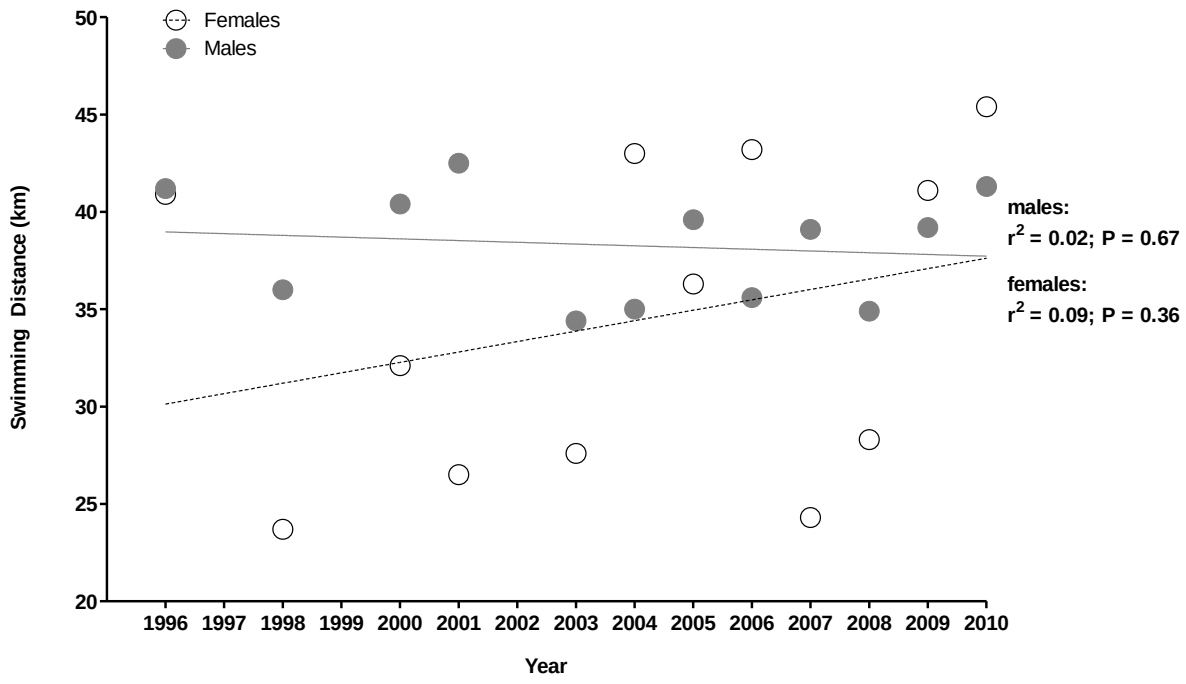
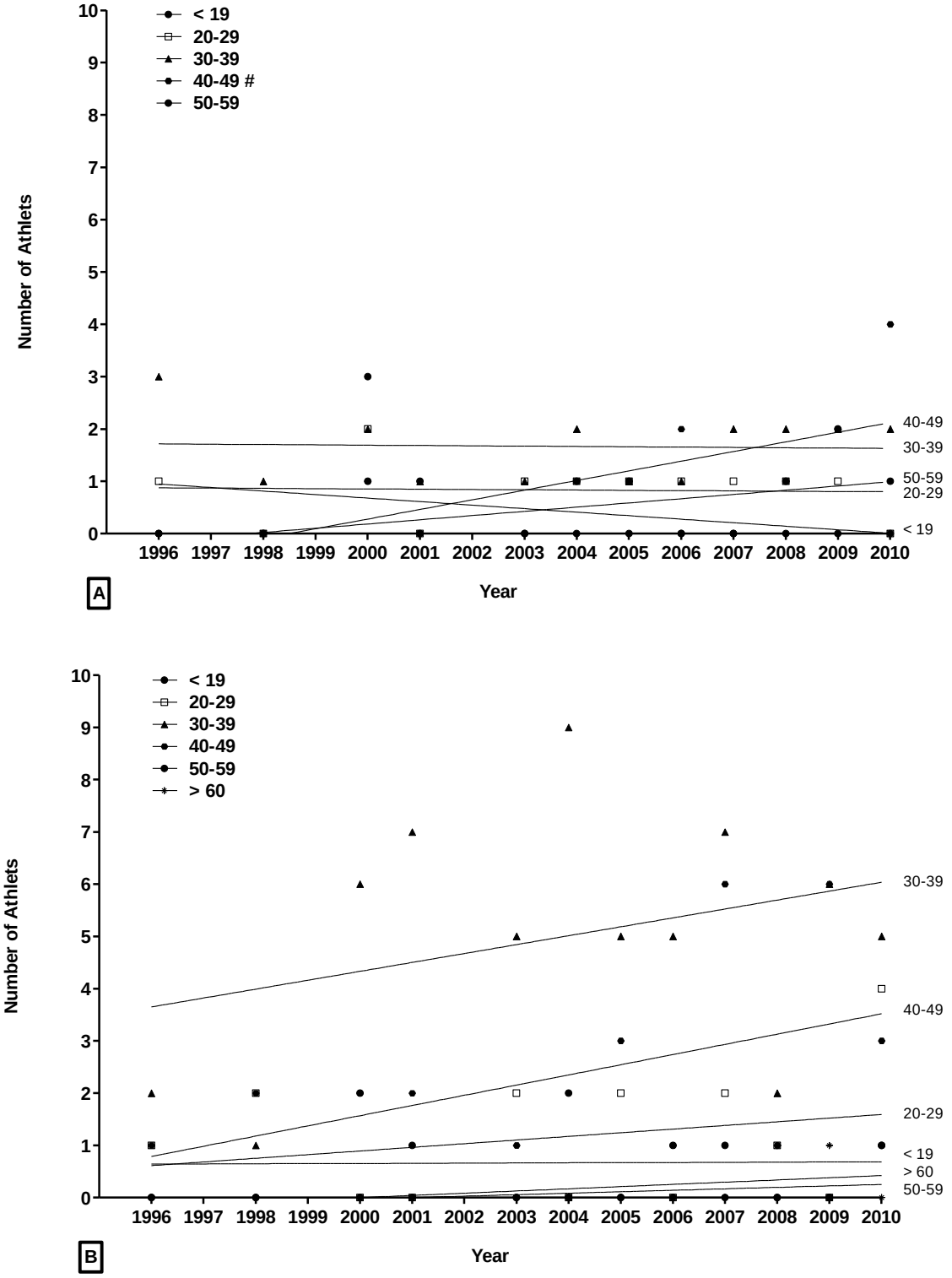

Females
Males
Swimming Distance (km)
50
45
40
35
30
25
20
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year
males:
r2 = 0.02; P = 0.67
females:
r2 = 0.09; P = 0.36

Figure 2


< 19
20-29
30-39
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50-59
Number of Athlets
Year
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50-59
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20-29
30-39
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Number of Athlets
Year
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40-49
20-29
< 19
> 60
50-59

Figure 3

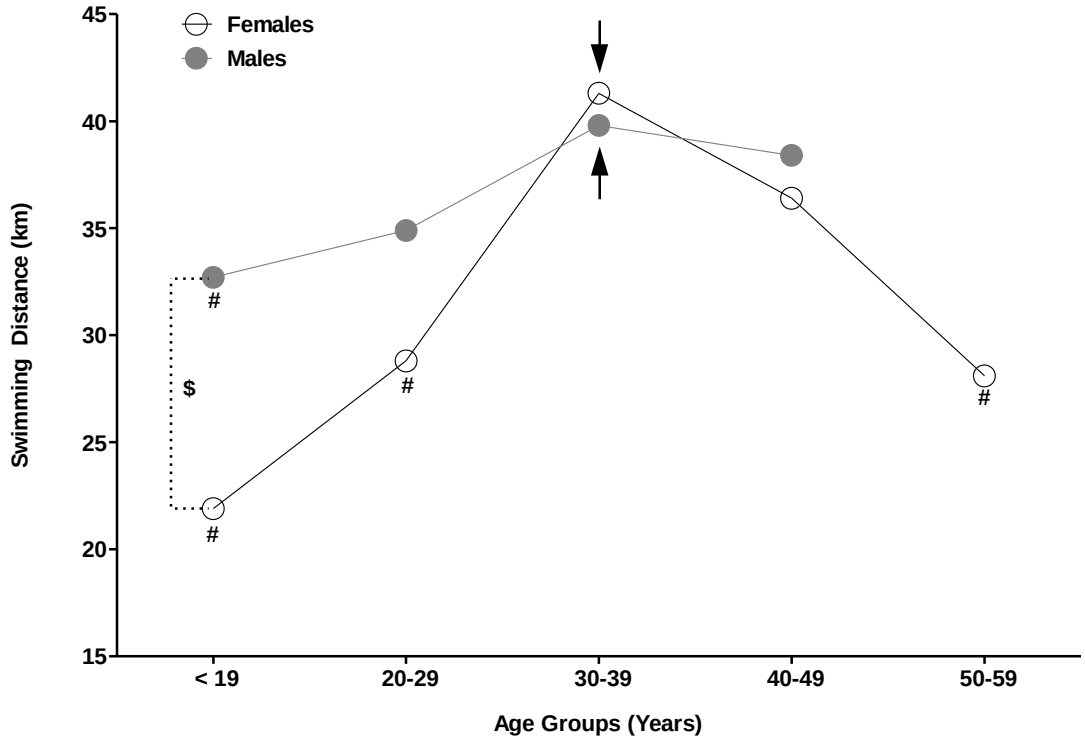
Females
Males
45
40
35
30
25
20
15
Swimming Distance (km)
#
$
#
#
#
< 19
20-29
30-39
40-49
50-59
Age Groups (Years)

Figure 4

Curriculum vitae

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