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PARTICIPATION AND PERFORMANCE DURING THE EXTREME OPEN-WATER 'FREEDOM SWIM' RACE FROM 2001 TO 2018

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Abstract:
Introduction: Ultra-endurance and extreme open water present a unique exercise environment that stresses both the physiological and psychological characteristics of a swimmer. In recent years, a number of studies have specifically focused on Northern Hemisphere races. The aim of this study to analyse the participation and performance trends of the Freedom Swim extreme open water swim from 2001-2018. **Methods:** A retrospective analysis of publicly available data was used to assess participation and performance. **Results:** Participation did not significantly increase over the period of interest in either gender. However, for every year there were significantly more men than women taking part. Mean finishing time was not significantly different between genders, however, in 2008, men were significantly faster but in 2010, women were significantly faster. **Conclusion:** the present study provides evidence that women's participation is open water sea swimming is significantly less than that of men, in accordance with previous research. Further, there was no significant difference in performance between men and women. These findings suggest that men and women achieve similar swimming performances in cold water long distance.

Keywords: swimming, cold water, endurance, performance, participation, gender

1. Introduction

Ultra-endurance and extreme open water present a unique exercise environment that stresses both the physiological and psychological characteristics of a swimmer (Judelson, Bagley, Schumacher, & Wiersma, 2015). In order to successfully complete an event, a swimmer must overcome factors such as mental and physical exhaustion (VanHeest, Mahoney, & Herr, 2004), hypothermia (Brannigan et al., 2009), ocean

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currents, unpredictable weather and various forms of wildlife (Judelson et al., 2015). These events require significant preparation and acclimatisation to fully be able to withstand the demanding requirements of swimming for long durations in low temperature waters (Brannigan et al., 2009; Keatinge, Khartchenko, Lando, & Lioutov, 2001). That being said, a number of studies in recent years have demonstrated an increasing interest in participation and performance trends in these ultra-endurance and extreme events (Eichenberger et al., 2012; Zaryski and Smith, 2005) including open water swimming (Eichenberger et al., 2012, 2013; Knechtle, Rosemann, Lepers, & Rüst, 2014).

Recent studies have focused primarily on the open water ultra-endurance events including the English Channel Crossing (France and United Kingdom) (Eichenberger et al., 2012), Manhattan Island Marathon Swim (United States of America) (Knechtle, Rosemann, Lepers, et al., 2014), Marathon Swim Lake Zurich (Switzerland) (Eichenberger et al., 2013), 'La Traversée Internationale du Lac St-Jean' (Canada) (C. A. Rüst, Knechtle, Rosemann, & Lepers, 2014), 'Catalina Channel Crossing' (United States of America) (Knechtle, Rosemann, & Rüst, 2015) and 10km events that form part of the FINA Open Water series (Vogt, Rust, Rosemann, Lepers, & Knechtle, 2013). However, these races, events and challenges are well investigated in the Northern Hemisphere but there is little to no research that investigates extreme open water endurance swimming in the Southern Hemisphere, let alone the participation and performance trends in an African context.

Although not a marathon swim in terms of distance, the 'Freedom Swim' is best classified as an extreme open water swim due to the difficult environment and cold water of the Atlantic Ocean. The event is held annually in Cape Town (South Africa) and is both popular and challenging (http://www.freedomswimseries.co.za). Swimmers attempt to traverse the area of open ocean from Robben Island to Blouberg Beach. The first recorded swim from Robben Island occurred in 1909 when Henry Charteris Hooper swam from the island to Cape Town Harbour (News24, 2013). Seventeen year later, the 15-year-old Peggy Duncan became the first woman to swim from the island to Cape Town in 1926. Since then, hundreds of swimmers have completed the crossing from the island to various points across the Cape Town coastline, including Blouberg Beach, Three Anchor Bay and Cape Town Harbour (News24, 2013). The even itself was started in 2001 and is typically held on the weekend of the Freedom Day Holiday (27th April), significant in South Africa's history commemorating the country's first democratic elections held in 1994. The race begins from Robben Island harbour and swimmers attempt to complete the 7.2km distance (the shortest measured distance) to the main land in the shortest amount of time. However, due to the strong southern current between the main land and the island, the distance can vary between 7.2 and 8.2 km. The race usually commences in the morning around 9am and is typically completed in around 1.5 to 3 hours (Table 2).

Studies exploring ultra- and extreme open water swimming events have demonstrated contrasting findings with regards to gender participation and

performance trends in some of the longest marathon swim events (Eichenberger et al., 2012; Fischer, Knechtle, Rüst, & Rosemann, 2013; Rüst, Lepers, Rosemann, & Knechtle, 2014; Vogt et al., 2013). Rüst et al., (2014) found that the sex differences during the 32-km 'Traversée Internationale du Lac St-Jean' decreased from ~14% in 1973 to ~4% in 2012. Eichenberger et al., (2012) showed that annual performances during the ~ 34 km 'English Channel Crossing' were similar between men and women, in contrast to Eichenberger et al., (2013) who demonstrated that men were 11.5% faster than women during the annual ~26 km 'Lake Zurich Swim'. More recently, some studies have focused specifically on the sex differences in participation and performance (C. A. Rüst et al., 2014; Vogt et al., 2013). However, during the 46-km 'Manhattan Island Marathon Swim', the best women were ~13 % faster than the best men (Knechtle, Rosemann, Lepers, et al., 2014). Similarly, during the 'Catalina Channel', women outperformed their male counterparts (Knechtle et al., 2015).

The disparities in performance may be in part due to differences in the distance of the races, water temperature and other environmental conditions, as well as physical characteristics of each participants (Rüst, Knechtle, & Rosemann, 2012). Women have been shown to have a smaller body size, smaller body density and shorter limbs which may result in lower body drag and better streamlined position in the water (VanHeest et al., 2004). These factors in conjunction with a higher body fat percentage could confer some protection or resistance from the temperature of the water in which swimmers compete and as such might allow women to outperform men. The aims of the present study were (i)to investigate the participation and performance trends in the 'Freedom Swim' from 2001-2018 and, (ii) to compare finishing time performances between men and women who successfully completed the race.

2. Methods

2.1 Study design

A retrospective analysis of the 'Freedom Swim' Race (Robben Island to Big Bay Beach) was performed using data that was publicly accessible (Big Bay Events, 2018). As all information pertaining to this study was publicly accessible, no ethical clearance was required.

2.2 Participants

All successful male and female solo swimmers undertaking the 'Freedom Swim' Race between 2001 and 2018 were considered for the retrospective analysis. All data were retrieved from https://www.bigbayevents.co.za/results/freedom-swim.html (Big Bay Events, 2018). Swimmers who registered a DNF (Did Not Finish) were excluded from analysis. Additionally, relays and team swims were not included. Finally, only swimmers who completed the event according to the Channel Swimming Association regulations (Channel Swimming Association, 2018) were considered, i.e. in a regulation

bather, swimming cap and goggles. Therefore, swimmers who completed the event in a wetsuit were excluded from the analysis.

2.3 Freedom Swim' and environmental conditions

As described above, the 'Freedom Swim' race begins from Robben Island harbour and swimmers attempt to complete the 7.2km distance (the shortest measured distance) to Blouberg Beach on the main land. Due to the strong sea currents between the main land and the island, the distance can vary between 7.2 and 8.2 km. Robben Island is located in the Atlantic Ocean and due to the presence of the Benguela current coming from the Antarctic Ocean, the surface water temperature can fluctuate from 8^{o} C to 18^{0} C and is subjected to the strong Cape Winds (Erasmus, Robertson, & van Hoving, 2018). This specific area of the ocean is rich in local wildlife including dolphins, seals, whales, jellyfish, sea urchins and the occasional presence of great white sharks (Branch, Griffiths, Branch, & Beckley, 2008). However, to date, there has never been a shark attack during the event. Furthermore, the surf conditions vary impart due to the strong Cape winds and as such, a large amount of variability in wave conditions occur, from flat water to massive swell (up to 8m) (Erasmus et al., 2018).

Table 1: Environmental data for each 'Freedom Swim' event is listed below.
(Data for 2001-2009 is unavailable)

	Air Temp	Water Temp	Wind	Rain	Humidity	Pressure	Cloud
21 April 2018	19	13.8	3mph NNW	0.0	67%	1017mb	0%
28 April 2016	22	13.2	3mph SSW	0.0	68%	1015mb	8%
11 April 2015	15	13.6	9mph ESE	0.0	73%	1024mb	23%
27 April 2014	18	13.4	7mph E	0.0	81%	1017mb	3%
8 May 2011	16	12.0	8mph SE	0.0	78%	1018mb	15%
2 May 2010	17	12.0	4mph S	0.7mm	91%	1018mb	87%
26 April 2009							
27 April 2008							
28 April 2007							
16 April 2005			Data unavailable.				
24 April 2004							
31 May 2003							
02 June 2002							
23 September 2001							

Data sourced from https://www.worldweatheronline.com/cape-town-weather-history/western-cape/za.aspx

2.4 Statistical analysis

The finishing time performances in minutes in both male and female swimmers completing the 'Freedom Swim' between 2001 and 2018 were analysed. Data are reported as mean ± standard deviation using the statistical programs Statistica (StatSoft,

Version 6.1; Statistica, Tulsa, OK, USA) and Prism GraphPad (GraphPad Software, Version 7; Prism GraphPad, La Jolla, CA, USA). Male and female participation was compared using 2x1 Chi Squared analysis. Mean swimming time was calculated in male and female swimmers who successfully completed the race and were compared using a Student's *t-test* (two-tailed for t-tests). Finishing times were converted to swimming speed ($m.s^{-1}$) (Eichenberger et al., 2012; Nevill & Whyte, 2005; Winter & Fowler, 2009). Linear regression analysis was performed on mean finishing time, winning finish time; mean swimming speed and winning swimming speed. Statistical significance was accepted at $p<0.05$.

3. Results

3.1 Environmental results

Environmental conditions including air and water temperature, wind (strength and direction), precipitation, humidity, barometric pressure and cloud coverage are listed in Table 1. Due to limitations of data availability, only conditions from 2010 – 2018 are reported.

3.2 Participation

From 2001 to 2018, 664 swimmers represented by 512 men and 150 women (77.4 and 22.6% of all participants, respectively) took part in the 'Freedom Swim' event (Table 2). Every year since the 'Freedom Swim''s inception demonstrated significantly more male participants compared to female participants ($p<0.05$). Although, men's participation in the event increased significantly from 2008-2010, but was not found to be significant during the entire period. However, linear regression analysis demonstrated that participation didn't increase significantly between 2001 and 2018 for either gender (-0.0630 and 0.105 Pearson's correlation co-efficient; $p=0.8379$ and $p=0.7310$, men and women, respectively). However, a large peak in male participants is noted in 2010 is possibly due to increased tourism as a result of the 2010 FIFA World Cup.

3.3 Finishing time results

The mean finishing time of all participants (Table 3) during the studied period was not significantly different between men and women ($p=0.050$; CI; -0.82 to 13.78). It is interesting to note that on two instances of the event, a significant difference was found between men and women (Table 2). In 2008, the mean completion time of men was significantly faster than the women ($n=51$, 193.7 ± 36.7 vs. $n=14$, 218.5 ± 31.7; $p=0.020$; men vs. women, respectively). In 2010, women on average complete the event faster than their male counterparts ($n=17$, 173.8 ± 30.8 vs. $n=83$, 190.8 ± 28.1; $p=0.047$; men vs. women, respectively).

Table 2: Summary of number of participants (n), Finishing Time (FT) and Range (Slowest-Fastest) for men and women for each instance of the Freedom Swim event from 2001-2018

		2001	2002	2003	2004	2005	2007	2008	2009	2010	2014	2015	2016	2018
Men	n	18	22	29	51	29	38	51	73	83	18	15	33	22
	FT	166.4 ± 19.2	161.0 ± 39.0	152.5 ± 27.8	141.0 ± 22.5	179.0 ± 30.2	143.4 ± 24.0	193.7 ± 36.7	144.2 ± 19.6	190.8 ± 28.1	145.1 ± 29.6	140.9 ± 33.8	157.2 ± 46.4	126.6 ± 22.2
	Range	132.0–196.0	112.0–263.0	106.0–235.0	105.0–215.0	125.0–242.0	94.0–198.0	119.0–269.0	96.0–203.0	108.0–250.0	95.1–187.2	91.7–201.1	92.7–272.6	89.8–171.5
Women	n	6	10	8	9	9	17	14	13	17	6	5	17	8
	FT	167.2 ± 16.9	183.9 ± 42.9	152.6 ± 18.9	139.0 ± 16.1	192.1 ± 27.6	155.1 ± 26.9	218.5 ± 31.7	142.3 ± 22.7	173.8 ± 30.8	140.1 ± 44.5	170.2 ± 55.8	176.1 ± 41.4	134.2 ± 23.4
	Range	139.0–189.0	123.0–248.0	118.0–172.0	113.0-163.0	155.0–237.0	117.0–206.0	115.0–252.0	95.0–174.0	129.0–227.0	105.1–200.1	111.9–237.1	106.5–241.6	102.2–164.6
P-value	N	**0.007**	**0.025**	**0.000**	**0.000**	**0.001**	**0.003**	**0.000**	**0.000**	**0.000**	**0.011**	**0.021**	**0.016**	**0.008**
	FT	0.922	0.084	0.995	0.378	0.121	0.068	**0.020^{M}**	0.392	**0.047^{W}**	0.403	0.159	0.075	0.219

Table 3: Overall finishing from 2001 to 2018 for men and women

	Men	Women	P-Value
No. Participants (n)	512	150	0.000
Finish Time (Mean ± SD; min)	161.9 ± 36.4	168.9 ± 38.6	0.050
Range (Fastest-Slowest; min)	89.78 – 272.6	95.0 – 252.0	

3.4 Performance analysis

Linear regression analysis of the mean finishing time was not significantly different for either gender (Figure 3A). However, linear regression of winning time for both genders (Figure 3B) significantly decreased over the period (Men: $r^2 = 0.55$, $p=0.004$; Women: $r^2 = 0.34$, $p=0.037$). These results are confirmed by results of the linear regression analysis for speed where mean swimming speed for men and women did not significantly improve over the period (Figure 4A). But as expected the winning time swimming speed (Figure 4B) for both genders had significantly improved over the period (Men: $r^2 = 0.60$, $p=0.002$; Women: $r^2 = 0.36$, $p=0.030$).

4. Discussion

The main findings of this study were (1) that participation in the 'Freedom Swim' did not significant increase over the period from 2001-2018, (2) significantly more men took part in the event than women, (3) overall men and women did not significant differ with regards to performance (i.e. finishing time) and (4) mean finishing time and swimming speed did not significantly change over the period but (5) winning finish time significantly decreased and winner swimming speed significantly increased for both men and women over from 2001 to 2018.

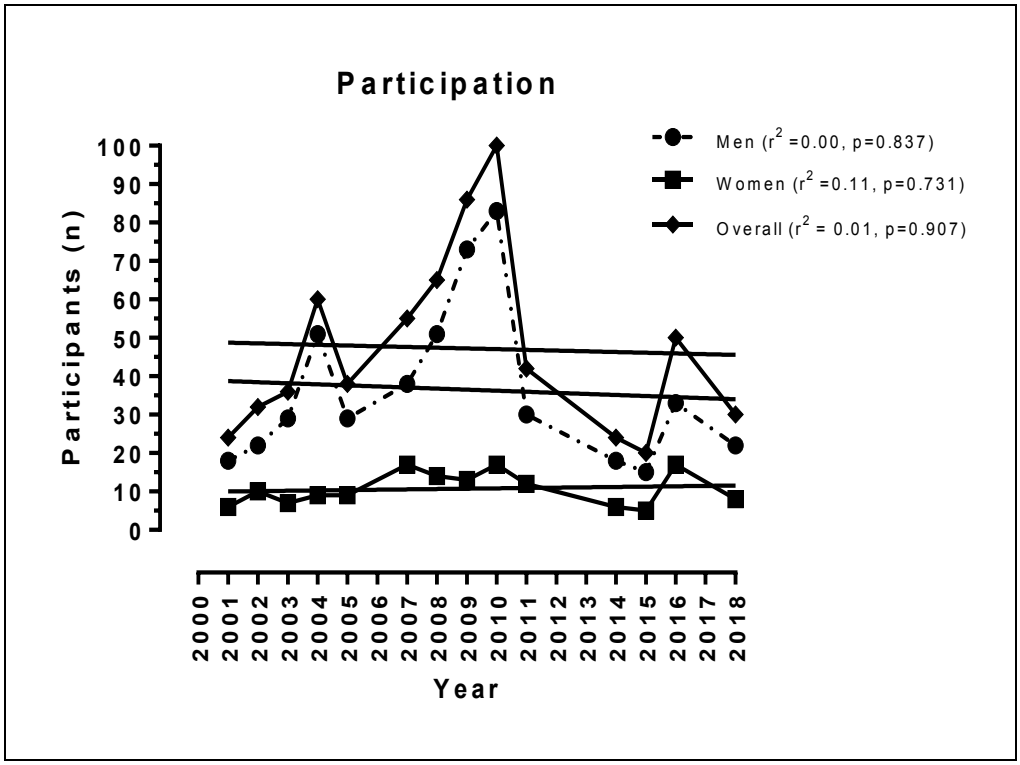

Figure 1: Number of 'Freedom Swim' participants from 2000 to 2018 for men, women and overall. Black circle indicates men, black square indicates women and black diamond indicated overall. Line of good fit (linear regression) is indicated for each participant group.

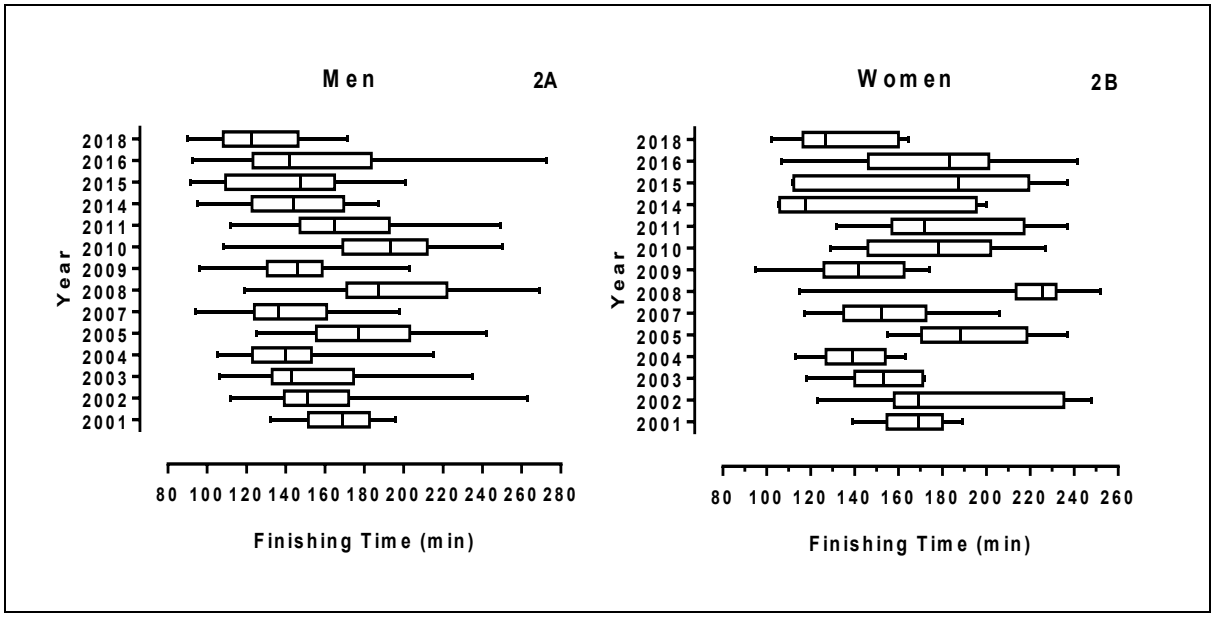

Figure 2: Box and whisker plots of the men's (2A) and women's (2B) finishing times (min) for the 'Freedom Swim' event held between 2001 and 2018. The ends of the box are the upper and lower quartiles, spanning the interquartile range. The median value is represented by the vertical line in the centre of the box. The whiskers are the two lines that extend outside the box which represent the lowest and highest observations.

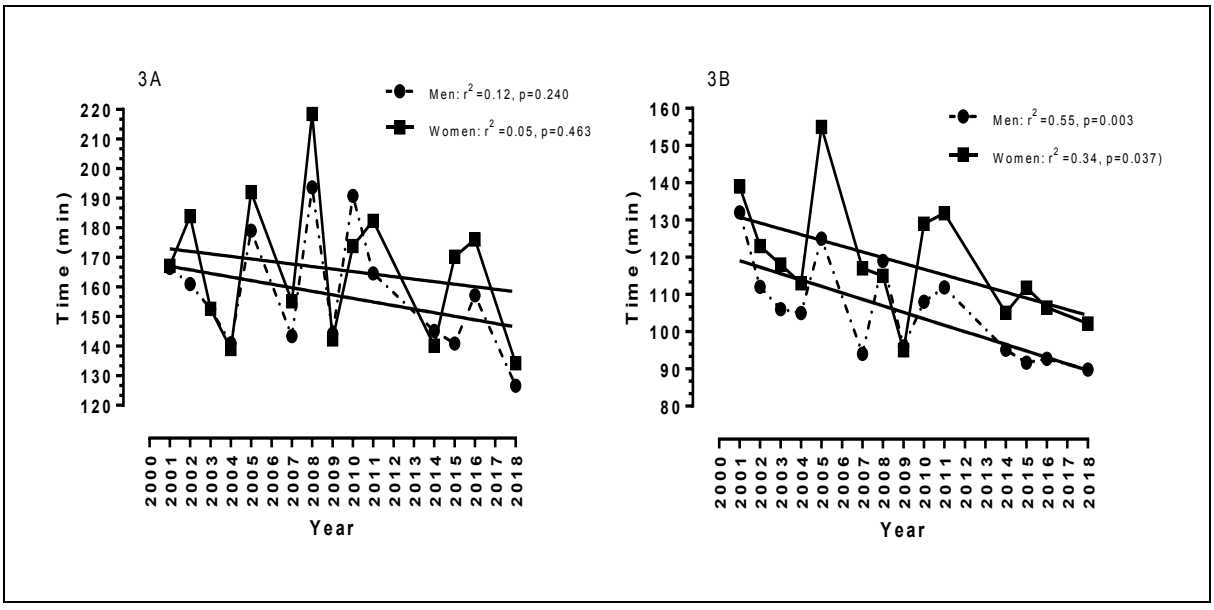

Figure 3: Linear regression analysis of mean finishing time (min) (3A) and winning finishing time (min) (3B) over the period of 2001-2018. Black circles with broken connecting line indicate men and black circle with solid black connecting line indicates women.

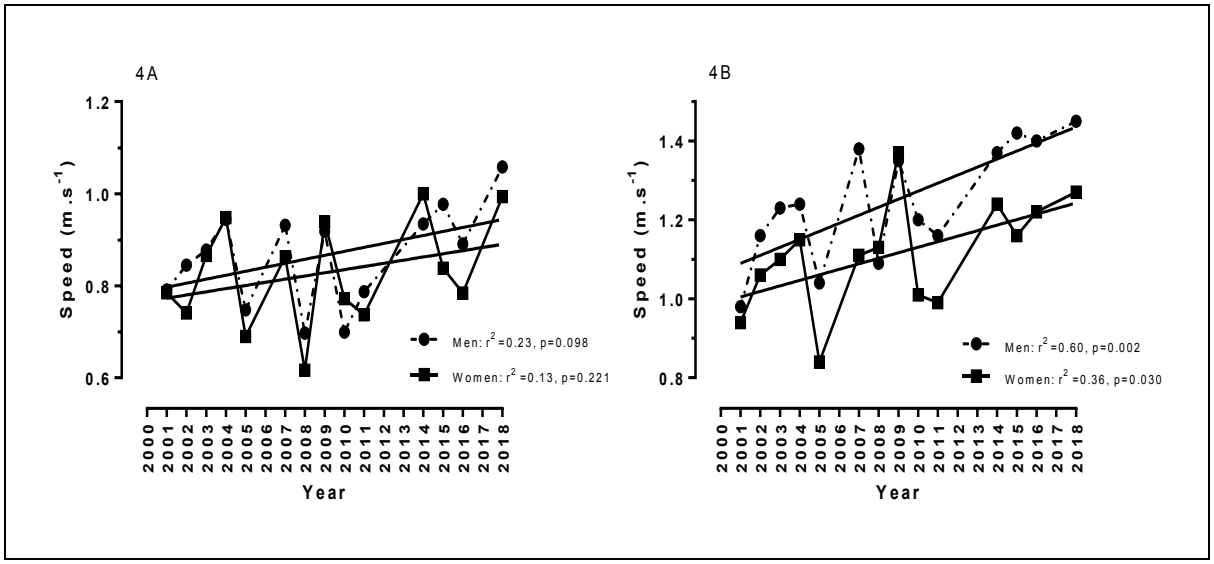

Figure 4: Linear regression analysis of mean swimming speed ($m.s^{-1}$) (4A) and winning swimming speed ($m.s^{-1}$) (4B) over the period of 2001-2018. Black circles with broken connecting line indicate men and black circle with solid black connecting line indicates women.

4.1 Participation in the 'Freedom Swim'

Since the first documented crossing from Robben Island to Cape Town Harbour in 1909, hundreds of swimmers have completed the crossing from Island to various points across the Cape Town coastline (News24, 2013). The first 'Freedom Swim' event was held in 2001 and has had an iteration nearly every year since (Big Bay Events, 2018) barring those instances where it was called off due to poor weather conditions (Give years?). A total of 664 swimmers have successfully competed in the event and of those competitors, 22.6% were women. This gender disparity has been similarly reported for the 'English Channel Swim' (~30%) (Eichenberger et al., 2012), "Catalina Crossing" swim (36.5%) (Knechtle et al., 2015), 'Maratona del Golfo Capri-Napoli' (22.9%) (Rüst et al., 2014), 'Manhattan Island Marathon Swim' (29.6%) (Knechtle, Rosemann, Lepers, et al., 2014) and the 'Marathon Swim in Lake Zurich' (33.3%) (Eichenberger et al., 2013). Low participation rates in South African elite level swimming have been previously investigated by (Hill and Grand'Maison, 2017). In this study, it was shown that women have been significantly under-represented, if included at all, at the Olympic Games since South Africa's re-inclusion in international sport in 1992 (Hill and Grand'Maison, 2017).

Although the 'Freedom Swim' in Cape Town is not a typical marathon swim with a distance, current depending, of 7.8 to 8.2 km, it is still considered an extreme swim due to the low water temperature (8-13 degrees C) and unpredictable weather. However, unlike many events where there has been a marked increase in participation from year to year (Eichenberger et al., 2013; Knechtle et al., 2015; C. A. Rüst et al., 2014) the 'Freedom Swim' showed a relatively stable participation rate. However, there was a sharp increase in participation from 2008 to 2010, however the reason behind this spike

is unclear and could possibly be attributed to increased tourism resulting from the 2010 FIFA World Cup held in the country then.

4.2 Performance in the 'Freedom Swim'

The second main finding of the study was that overall finishing time for the 'Freedom Swim' was not significantly different between men and women. Although, it is interesting to note that on two instances of the event, a significant difference was found between men and women. In 2008, the mean completion time of men was significantly faster than the women. But in 2010, women on average complete the event faster than their male counterparts. It has been previously shown that women have outperformed men in other demanding ultra-marathon/ extreme swims from around the world (Knechtle, Rosemann, Lepers, et al., 2014; Knechtle et al., 2015; Knechtle, Rosemann, & Rüst, 2014). This phenomenon is difficult to explain, however it had been previously suggested that the higher body fat in female swimmers could account for the advantage in lower water temperature (Knechtle, Rosemann, Lepers, et al., 2014; Knechtle et al., 2015; Knechtle, Rosemann, & Rüst, 2014). Knechtle et al,. (2010) showed that female ultra-endurance swimmers had more body fat than male ultra-endurance swimmers and thus can remain in the cold water for longer (Keatinge et al., 2001). Since the ocean temperature for the 'Freedom Swim' can vary between 8 and 14 degrees C during the race, it is therefore possible that a higher body fat percentage insulates the skeletal muscle better, thus potentially accounting for the lack of significant difference in performance (Acevedo et al, 1997; Knechtle et al, 2009).

Further, the higher body fat in women may have a secondary effect in that the increased body fat improves buoyancy in the water (Eichenberger et al., 2012), a more horizontal position (Ulsamer, Rüst, Rosemann, Lepers, & Knechtle, 2014) and a larger reduction in drag (Kjendlie & Stallman, 2008). This in turn affords the swimmer a better swimming economy resulting in less power being required to maintain body position, allowing more energy to be expended during propulsion (Kjendlie & Stallman, 2008; Ulsamer et al., 2014). The mean swimming time and mean swimming speed did not significantly improve from 2001 to 2018 for either men or women in addition to men and women not being significantly different from each other. This could be in part explained that women had a greater swimming efficiency and thus being able to maintain a similar swimming speed to that of men. Eichenberger et al (2012) found that men and women completed the 'English Channel Swim' at similar velocities (men 0.84 ± 0.18 $m.s^{-1}$; women 0.89 ± 0.20 $m.s^{-1}$) at water temperatures between 15 and 18 °C.

The lack of significant difference in mean finishing time and mean swimming speed could also be explained by the level of fitness of the swimmers taking part in the 'Freedom Swim'. The race attracts elite and amateur open water swimmers alike. The race itself is often frequented by a number of swimmers who take part for fun or for a challenge as is evident in the average slowest time being 225.2 minutes and 210.6 minutes for men and women, respectively. This is further supported by the fact that a significant improvement was found in the winning finish time and winning swimming

speed over the period for both men and women from 2001 to 2018. A similar trend was found during 'La Traversee Internationale du Lac St-Jean' where the fastest women improved significantly over time (Rüst et al., 2014). It is interesting to note that whilst the mean and overall finishing time and swimming speeds were not significantly different, the winning finish time and swimming speed of the men were significantly faster than the women. The mean winning finish time for men was ~11% faster than the mean winning finish time for women over the investigated period. The difference in mean winning finishing during the period could be accounted for by the significant difference in winning swimming speed for men (~1.25 $m.s^{-1}$) and women (1.11 $m.s^{-1}$) for the women. These results do concur with previous findings over similar distances (Vogt et al., 2013), cautious interpretation of winning finish time and swimming speed is required as only the top finishers (men and women) were considered.

4.3 Limitations

This study has a number of limitations since potential cofounding variables such as age (Knechtle et al. 2011), anthropometric and physical characteristics (Knechtle et al. 2010), training status and competitive level (Knechtle et al. 2010), previous swimming and competitive experience (Knechtle et al. 2011), water temperature over the entire course of the race (Eichenberger et al. 2013), sea conditions on the day (Hollander & Acevedo, 2000) and nutritional intake including food (Weitkunat, Knechtle, Knechtle, Rüst, & Rosemann, 2012) and fluids (Wagner, Knechtle, Knechtle, Rüst, & Rosemann, 2012) were not considered. It is therefore likely the inclusion of these variables could have an influence the overall outcome of the study and thus the results need to be interpreted with caution.

5. Conclusion

In conclusion, the present study provides evidence that women's participation is open water sea swimming is significantly less than that of men, in accordance with previous research. Further, there was no significant difference in performance between men and women. These findings suggest that men and women achieve similar swimming performances in cold water long distance events which could be attributed to anthropometric and physical characteristics of the female body. Further studies are required in order to fully elucidate the gender differences in during long distance swimming events in cold water.

Conflict of interest

There are no conflicts of interest to declare.

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The author certifies that he has no commercial associations (e.g., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

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