Female Endurance Racing: The Case for Equality

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ABSTRACT

WOMEN RACE SHORTER DISTANCES THAN MEN IN CERTAIN ENDURANCE SPORTS, INCLUDING EVENTS IN RUNNING, NORDIC SKIING, AND CYCLING. OUTDATED RATIONALES FOR DIFFERENCES IN RACE STANDARDS BETWEEN MEN AND WOMEN ARE NOT BASED ON CURRENT KNOWLEDGE OF THE FEMALE ENDURANCE ATHLETE'S PHYSIOLOGY. THE PURPOSE OF THIS ARTICLE IS TO EXAMINE EVIDENCE THAT SUPPORTS THE ARGUMENT THAT ATHLETES OF BOTH SEXES SHOULD COMPETE WITHIN THE SAME RACE STANDARDS.

INTRODUCTION

Inequalities exist between certain standards for women's and men's organized endurance sports. For example, the current National Collegiate Athletic Association (NCAA) championship cross country distances for men and women vary by 2 km; at women's meets, competitors run only 6 km while men run 8 km (National Collegiate Athletic Association. 2015–2016 Cross Country and Track and Field Rules. 2014. Available at: http://www.ncaapublications.com/productdownloads/TF16. pdf. Accessed February 19, 2016). According to the current International Ski Federation (FIS) standards for cross-country skiing, the longest sanctioned event for female athletes is 30 km, whereas for men it is 50 km (FIS). (The International Ski Competition Rules. Book II. Cross-Country. 2015. Available at: http://www.fis-ski.com/mm/Document/documentlibrary/Cross-Country/02/95/69/ICRCross-Country2015_clean_Nov15_English.pdf). Accessed February 19, 2016. In cycling, the sport's international governing body, Union Cycliste Internationale (UCI), requires that the longest one-day road race in the Olympic Games be 140 km for women, but doubles the race length to 280 km for male athletes (22). In addition to distance, some time standards also reflect gender inequality in endurance sports; although women only race half the distance as men in one day, the UCI also restricts the number of days the athletes compete (22). In 2015, the longest men's stage race was the Tour de France, which included 21 stages. By contrast, the longest women's race was the Giro Rosa with only 10 (23). In a landscape of endurance sports that do have the same standards for men and women including triathlon, track and field, and many ultra-endurance competitions, the differences in some of the standards prescribed by the NCAA, FIS, UCI, and others are more pronounced.

The abridged endurance events for female athletes that do persist do so in what has been a steep curve of change for gender equity in the sport. Before 1972, for example, women were not allowed to run the Boston Marathon, and the first women to run the marathon in the Olympics waited until 1984 (Boston Athletic Association. Boston Marathon History: Boston Marathon Milestones. Available at: http://www.baa.org/races/boston-marathon/boston-marathon-history/boston-marathon-milestones. Accessed February 19, 2016, International Olympic Committee. Women's Marathon Event Results. Available at: http://www.olympic.org/athletics-marathon-women. Accessed February 19, 2016). The popular belief had been that the rigors of endurance sports like running would harm a woman's body (7). Indeed, it was only after a variety of factors, including an American College of Sports Medicine (ACSM) statement, that a concerned International Olympic Committee (IOC) permitted the women's marathon (6). The ACSM helped set the stage for women's endurance competition, noting, "There exists no conclusive scientific or medical evidence that long-distance running is contraindicated for the healthy, trained female athlete. The ACSM recommends that females be allowed to compete at the national and international level in the same distances in which their male counterparts compete" (2). In retrospect, the ACSM's statement seems obvious, but it was just a short 30 years ago that the idea of an able, elite female endurance athlete took verification. Joan Benoit won the first Olympic women's marathon with a time of 2:24:52

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(5:31 min/mile) (International Olympic Committee. Women's Marathon Event Results. Available at: http://www.olympic.org/athletics-marathon-women. Accessed February 19, 2016). The fact that her time was faster than over 50% of the previous male winning times was evidence that trained female endurance athletes were not only capable, but fast too (International Olympic Committee. Men's Marathon Event Results. Available at: http://www.olympic.org/athletics-marathon-men. Accessed February 19, 2016).

Because more women have begun competing in endurance sports, achievement gaps between the sexes narrowed significantly. According to the International Association of Athletics Federations, in 1970 the women's world record for the marathon was 3:02:53, whereas the record for the men was almost an hour faster at 2:09:28. In 2015, that gap has closed to only minutes–the women's record currently stands at 2:15:25 and the men's at 2:02:57. But despite performance progress, and any cultural change it may have encouraged, inequalities still exist in endurance race standards. Part of the reason for this may be that there remains a misunderstanding of female athletes' physiology regarding endurance capacity. With the opportunity to properly progress training programs, female athletes can transition to the longer races. The purpose of this article is to argue that, based on the science of exercise physiology, there is no justification for uneven standards in endurance sports between men and women. Specifically, maximal oxygen capacity, strength and power, and substrate utilization during exercise will be discussed to show that athletes of both sexes could compete within the same event limits in their respective events.

PHYSIOLOGY AS EVIDENCE FOR EQUAL COMPETITION STANDARDS

MAXIMAL OXYGEN UPTAKE

Maximal aerobic capacity is an important predictor of performance in endurance events (12,18,20). $\dot{V}O_2$max = Q × a − $\dot{V}O_2$ difference; thus there are both central and peripheral physiological factors which contribute to the ability to consume and use oxygen. The peripheral factors relate to metabolic functions within skeletal muscle or oxygen extraction at the cellular level. These factors include, but are not limited to, the number and size of mitochondria, mitochondrial enzyme activity, myoglobin, and capillary density (4). The central factors relate to pulmonary diffusion, the oxygen-carrying capacity of the blood, and cardiac output. The latter 2 are where the profound differences between men and women are typically found (4,11). On an average, men have more hemoglobin than women. Typical values for men range from 15 to 16 g per 100 mL of blood versus 14 g per 100 mL of blood in women. The discrepancy results in a difference in oxygen-carrying capacity between the sexes, which directly relates to oxygen consumption (16). In addition, and perhaps more importantly, is the difference in cardiac size between men and women. On an average, women have smaller hearts resulting in lower resting, submaximal, and maximal stroke volumes (23). It appears that females are at a disadvantage because of a difference in left ventricular end-diastolic volume, which affects preload. A lower preload leads to a reduced ability to use the Frank-Starling mechanism and a subsequent reduction in ejection fraction and stroke volume (23). If maximal stroke volume is lower, then cardiac output and thus $\dot{V}O_2$max will be lower as well.

The important difference in $\dot{V}O_2$max between men and women is certainly one variable that explains the sex difference in performance times among the winners in endurance racing, but it does not indicate that women lack the exercise capacity to participate in events of similar distance and duration as men. Indeed, in trained individuals, aerobic capacity of female athletes is quite high. $\dot{V}O_2$max values of 63.2 ± 5.2 mL·kg^{-1}·min^{-1} have been reported in elite female cyclists with similar values reported for national level triathletes (63.2 ± 3.6 mL·kg^{-1}·min^{-1}) (1,18). Higher values have been reported in trained female Nordic skiers (65–74 mL·kg^{-1}·min^{-1}) (17). In addition, during submaximal exercise, women compensate for lower stroke volume with higher heart rates in an effort to maintain cardiac output (23). Previous research on trained runners has found that women have higher submaximal values such as % $\dot{V}O_2$max at velocity OBLA or % $\dot{V}O_2$max than men and that women compensate for lower $\dot{V}O_2$max values by racing at a higher percentage of their maximum (14,15,19).

Because elite female endurance athletes have $\dot{V}O_2$max values well above average men and even above some competitive male endurance athletes, they clearly have the exercise capacity to compete over the same courses and distances as their male competitors. The rationale that must inform current endurance competition standards–that women are somehow less physically capable than men–gains no traction here. In truth, trained women possess the aerobic capacity to justify even race standards across all endurance sports.

STRENGTH AND POWER

To be successful in endurance racing, one needs more than aerobic capacity –strength and power are also related to performance (5). Significant differences exist regarding strength between the sexes. On an average, women are 40–60% weaker than men in the upper body and 25–30% weaker in the lower body (24). Much of that difference can be explained by size; men are often bigger than women and so possess more muscle mass. Indeed, if strength is expressed relative to body size, the difference between men and women is reduced dramatically (9).

In endurance sports, although strength is clearly important to the overall performance, it is power–force × distance/time–that may be the more important variable. Success in sports like cycling is not related to absolute power–rather, it is related to the power-to-weight ratio or relative power (8). Similar to strength, the differences in power are reduced when power is expressed relative to body size (22). It can be difficult to compare the power profiles between men and women in endurance sports because the two race different lengths; however, in a unique study, Lim et al. (2011) examined the physiological profile of elite male and female cyclists over the same course and distance. As expected, the researchers found that the men had higher $\dot{V}O_2$peak values (67.6 ± 2.5 versus 53.9 ± 3.8 mL·kg^{-1}·min^{-1}), higher power at $\dot{V}O_2$peak (415.6 ± 22.9 versus 312.5 ± 27.0 W), and higher power at lactate threshold (LT) (288.6 ± 11.3 versus 202.7 ± 22.5 W). Interestingly though, if power was expressed as a percentage of LT, there were no differences between men and women (77 ± 4 versus 77 ± 4%). In addition, there were no significant differences in time spent below, at, or above LT during racing. Female elite cyclists seemed to have similar relative power profiles and pacing strategies as their male competitors (13).

As with aerobic capacity, we also see a sex difference in absolute strength and power, and we see smaller differences in relative strength and power. These gaps likely relate to the performance discrepancies observed in men's and women's racing. The differences do not, however, concern the ability of women to perform over long durations. Again, the rationale that women are weaker and thus cannot race the same courses as men is not grounded in physiological truth.

SUBSTRATE UTILIZATION

Significant differences between the sexes also exist regarding substrate metabolism during endurance exercise. Interestingly though, these differences provide evidence that women may actually be more suited to long-duration exercise than men. Women tend to oxidize more fat versus carbohydrates during prolonged exercise than men (10,21,25) (Union Cycliste Internationale [UCI]. UCI Cycling Regulations. Part II: Road Races. Available at: http://www.uci.ch/mm/Document/News/Rulesandregulation/17/42/14/2-ROA-20160101-E_English.pdf. Accessed February 19, 2016. Union Cycliste Internationale [UCI]. UCI Road Calendar. Available at: http://www.uci.ch/road/calendar/#date=20150219&view=list&categ=0&country=0&classc=0. Accessed February 19, 2016.). Because the ability to effectively use fat as fuel is critical to endurance success, women may have an advantage regarding metabolism. The mechanisms responsible for the difference in substrate use are unclear, but several hypotheses have been suggested. First, estradiol–the female sex hormone–has been associated with reduced levels of lipoprotein lipase (LPL). LPL is an enzyme responsible for the breakdown and storage of triglycerides in adipose tissue. A reduction in LPL activity may increase triglyceride use in skeletal muscle (3,25). Another possible mechanism for the sex difference in substrate metabolism is the association of higher levels of catecholamines with women's higher levels of estrogen. Increased catecholamine levels raise the activity of hormone-sensitive lipase–an enzyme responsible for the mobilization and use of fats which can be used as fuel during prolonged exercise. In addition, increased levels of catecholamines are also associated with more growth hormone synthesis. Growth hormone opposes the effect of insulin thereby decreasing glucose metabolism and increasing fat metabolism (3,25). Lastly, estrogen has been associated with an increase in the activity of enzymes of fat oxidation including carnitine acyltransferase I, which moves fatty acids into the mitochondrial matrix for oxidation (25).

In this instance, the physiological difference is not a limiter that may need to be overcome; instead, it is an advantage females have over males. The ability to use fat as fuel is essential for long-distance submaximal endurance events. Because women rely more heavily on fat as fuel during prolonged exercise, they may actually be better suited to race long distances than their male counterparts.

CASE STUDIES AS EVIDENCE FOR EQUAL COMPETITION STANDARDS

According to physiological factors critical to success in endurance competition, including maximal oxygen consumption, strength and power, and substrate metabolism, sex differences justify a re-evaluation of current endurance competition standards in a variety of sports. But case studies can reinforce this conclusion. If doubts about female athletes' endurance fortitude relative to men remain, consider the examples of 2 "ultra-distance" races, the Badwater 135 and the Ironman Triathlon.

"Ultra-distance" is a term used to describe any race in a variety of disciplines that exceeds traditional competitions in length and time. For example, although a marathon is a traditional endurance event at just over 26 miles, a race of 50 miles or more may be considered "ultra." The Badwater 135 is an example of just such an event and has been described by race organizers as "the world's toughest foot race." Participants run 135 miles (217 km) from Death Valley to Mount Whitney, CA. The conditions and terrain are demanding; temperatures can reach well over 100°F and runners must ascend and descend steep technical terrain. In 2002 and 2003, female athlete Pamela Reed was the overall winner of the Badwater 135. In 2002, Reed dominated the race finishing over four hours ahead of a field of 58 finishers–42 men and 15 women. She won by a slimmer margin the next year (under 25 minutes), but still ahead of 31 men and 14 women. Reed's case study illustrates that a female athlete's physiology is suited for endurance competition and beyond.

In the 2014 Hawaii Ironman Competition–another grueling ultra-endurance event consisting of a 2.4 mile swim, a 112 mile cycle, and a 26.2 mile run–the female winner proved that she was not only capable of competing over the same distance as men, but she was faster than many of them as well. Mirinda Carfrae won the race for the women with a time of 9:00:55. In the course of winning the women's race, she beat 19% of the professional men's field and only 3 of the 1380 amateur male finishers posted a faster time. In addition, she set a course record for the run portion of the event–only 4 of the professional men and none of the amateur men outran her.

Carfrae's and Reed's successes illustrate the faulty reasoning in creating uneven standards across endurance sports. If a woman is capable of racing 140.6 miles of swimming, cycling, and running or can endure running 135 miles in desert-like terrain and she can do so faster than most men, then why do the inequalities still exist in racing today? And while Reed and Carfrae are unique examples of spectacular athletes, they are not alone–many women raced with them in those competitions and raced well. Their combined efforts provide even more evidence of the capability of female athletes in endurance sports.

CONCLUSION AND RECOMMENDATIONS

More than 30 years ago, the ACSM issued a statement declaring there were no scientific data supporting the notion that long-distance running was harmful to women. The organization went on to recommend that races of equal distance be open to women (2). In 1984, the IOC allowed the first women's Olympic marathon and the idea of a capable female endurance athlete increasingly took shape. But change in other running disciplines and change in other endurance sports has stalled. There are still discrepancies between men and women in race standards spanning a range of endurance sports, including long-distance running, Nordic skiing, biathlon, swimming, and nearly all disciplines of cycling. Trained women possess the aerobic capacity and the strength and power to complete the same courses as men. In addition, the difference in substrate metabolism between the sexes–an increased fat utilization by women–may well serve as an advantage over long-race durations. It is clear that women are capable of completing events of the same distances as men.

The examples of Joan Benoit, Pamela Reed, and Mirinda Carfrae–female endurance athletes among many–serve not as exceptions to a rule, but as lessons for progress. From our current perspective, the truth is that some of the women's endurance racing standards are relics of a bygone era. The physiological and historical evidence is clear–women can compete by the same endurance standards as men.

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