Commentaries on Viewpoint: The two-hour marathon: what’s the equivalent for women?

THE WOMEN’S PHYSIOLOGICAL EQUIVALENT OF A 2-H MARATHON

TO THE EDITOR: Hunter et al. (1) are to be congratulated for their insightful commentary regarding the equivalent of a 2-h marathon for women. It is a difficult task, as there are many possible determinants of marathon performance (not just physiological) and there is little published research about the capabilities of elite marathon runners. Nonetheless, we would like to suggest that one approach is to estimate the physiological requirements for a man to complete a 2-h marathon, followed by determination of the equivalent physiology in women, and then calculation of the time that a woman might achieve with this physiology. If we start with the simple physiological model provided by Joyner (3) [marathon running speed = VO2max × lactate threshold × running economy], then the speed required to complete a 2-h marathon (21.0975 km/h) could be achieved with a VO2max of 76.9 ml·kg⁻¹·min⁻¹ (4), a lactate threshold of ~81% VO2max (5), and a running economy of 175 ml·kg⁻¹·km⁻¹ (2). In considering that men and women appear able to obtain the same LT (relative to VO2max) and RE (1), the remaining calculation is to estimate the equivalent VO2max for a female [66–69 ml·kg⁻¹·min⁻¹ given the 10–14% difference between men and women (1)]. Putting these values into Joyner’s equation produces estimated marathon times of 2:13:20 to 2:20:32. Thus, although Radcliffe’s time is exceptional, we do not believe that it is possible to state unequivocally that the physiological equivalent of the men’s 2-h marathon has already been achieved by a woman.

REFERENCES

David Bishop
Danny Christiansen
Jon Bartlett
Institute of Sport, Exercise and Active Living (ISEAL)
Victoria University, Australia

COMMENTARY ON VIEWPOINT: THE TWO-HOUR MARATHON: WHAT’S THE EQUIVALENT FOR WOMEN?

TO THE EDITOR: The two-hour marathon will be a significant benchmark for human performance (1), as will the 3 min 30 sec statute mile. Using regression analyses we may predict with reasonable precision (as the performance gain has been pretty linear) that the latter will be achieved around 2038. Regarding the marathon, then predictions are far less reliable; for example, a consistent reduction in the record was achieved to 1970, and one may predict the 2-h benchmark to have been passed in 1985. So much for statistical predictions of extreme performances (i.e., of record times). Since 1970, the marathon record has reduced but at a lesser rate—using this information we may now predict the men’s 2-h marathon to be broken sometime between 2035 and 2045. Now let’s consider the women’s marathon record; until 1970 it could not exist because women were not allowed to run competitive marathons. Over the next 10-15 years of official recording, it decreased staggeringly, such that one may have incorrectly predicted the 2-h benchmark to have been surpassed by women in 1991! However, similar to men, the subsequent record fell but at a reduced rate. Using this information and excluding Paula Radcliffe’s performances as exceptional (i.e., removing them from the regression analysis), then we can make a loose prediction that women will break the 2 h 15 min mark anytime soon and the 2-h mark between 2035 and 2040. In fact, roughly the same time as men.

The 2-h marathon: what’s the equivalent for women? Simple—the 2-h marathon of course!

REFERENCE

David Gardner
Jim Craigon
School of Veterinary Medicine and Science
The University of Nottingham

THE NEED FOR MORE RESEARCH INVESTIGATING MECHANISMS OF MUSCLE FATIGABILITY IN THE FEMALE ATHLETE

TO THE EDITOR: The Viewpoint article by Hunter et al. (3) argues that the equivalent 2-h marathon for women has already been achieved by the impressive British athlete Paula Radcliffe. When detailing the factors that affect sex differences in performance, Hunter at al. (3) suggest that muscle fatigability would likely have a minimal influence among elite distance runners. However, this point is based upon insufficient evidence from locomotor exercise studies, both in the mode of exercise and population under consideration. In well-trained male runners, significant muscle fatigability develops throughout marathon running (4), but comparable data from a female population are scarce because the majority of mechanistic fatigue research focuses predominately on male populations (e.g., 2). When comparing mechanisms of fatigability in running between men and women, Temesi et al. (5) recently demonstrated an attenuated level of fatigability in women vs. men after a 110 km ultra-trail. Specifically, aspects of knee-extensor and plantar-flexor function were preserved in the female athletes compared with that of their performance-matched male counterparts. Similar findings have been found in recreational marathon runners (1); a lower drift in energy cost was observed in women during this study, which could reflect a less pronounced degree of additional motor unit recruitment during prolonged exercise as a consequence of the lower degree of muscle fatigability. More substantive evidence is
needed on this topic before we can conclusively say that mechanisms of muscle fatigability will have a minimal effect on explaining marathon performance between elite male and female distance runners.

REFERENCES


Stuart Goodall1
Kevin Thomas1
John Temesi2
Guillaume Y. Millet2
1Faculty of Health and Life Sciences Northumbria University
Newcastle, United Kingdom
2Human Performance Laboratory Faculty of Kinesiology University of Calgary
Calgary, Canada

HAS THE “EQUIVALENT TWO-HOUR MARATHON” FOR OLDER ATHLETES ALREADY BEEN ATTAINED?

TO THE EDITOR: Hunter et al. (2) proposed a very interesting Viewpoint concerning sex differences in marathon running. They argued that not only is the female world record in the marathon performed by Paula Radcliffe in 2003 comparatively better than the record for males but also that this performance is equivalent to being under the 2-h barrier for men. We hereby propose that data from master’s athletes (age >40 years old) also supports these viewpoints.

For the past 30 years, participation of master’s athletes in marathon has risen greatly. For example, in the New York marathon, master’s athletes represent more than 50% of male and 40% of female finishers, respectively (3). Masters athletes have also improved their performances especially in the older categories (e.g., average running time of the best men within the 70–74 year age group significantly decreased by ~17 min during the past three decades) (3).

Therefore, it would be interesting to establish a master athlete-specific model to estimate the equivalent performance of older compared with younger runners. The model could be built from 1) the number of masters athletes in marathon races, 2) their performance, and 3) the knowledge of the age-related alterations of some physiological parameters, such as maximal oxygen consumption (1), which is well known to limit performance (4). By doing so, we could understand whether for example, the performance of Canadian Ed Whitlock, who holds the marathon world record for age groups up to 80 years old with a time of 3:15:54 (5), is equivalent to the 2-h barrier. Therefore, the following question should be addressed in the future: What is equivalent to a 2-h marathon performance for master’s athletes?

REFERENCES


Thomas Cattagni
Laboratoire Motricité, Interactions, Performance EA 4234 Faculty of Sport Sciences University of Nantes, France

Romuald Lepers
INSEM U1093, Faculty of Sport Sciences University of Burgundy Dijon, France

THE SEX DIFFERENCE IN PERFORMANCE DEPTH REFLECTS A SEX DIFFERENCE IN COMPETITIVENESS

TO THE EDITOR: Hunter and colleagues (5) acknowledge that interpreting Radcliffe’s performances is complicated by the sex difference in performance depth, a difference they attribute to women enjoying fewer athletic opportunities. Although fewer opportunities for women undoubtedly can be impactful, this cannot provide a complete explanation for the sex difference in performance depth.

Crucial evidence comes from the U.S., where women’s opportunities and incentives have increased dramatically since the 1980s and, in distance running, no longer favor men (2, 3). Studies show that although the sex difference in running participation has disappeared, the sizable sex difference in performance depth has not been shrinking (1, 2, 4).

Evidence instead supports the hypothesis that the sex difference in performance depth reflects that more male than female runners possess a competitive orientation, an apparent requirement for elite performances (2). A recent study of 13,000 masters runners (40+ years) supported this by showing that men were more likely to choose to participate in competitive contexts (3). Specifically, although there was no sex difference in participation at road races, men were three times as likely as women to participate in distance events at track meets. This is remarkable because fast performances (relative to sex and age standards) occur 20 times more often at track meets. Thus track meets are competitions, whereas road races are generally recreational events. Furthermore, the sex difference in track meet participation did not decline from 1998 to 2012.

Thus the sex difference in performance depth partly reflects a sex difference in competitiveness not merely opportunities.

REFERENCES

TO THE EDITOR: The viewpoint that Paula Radcliffe’s world marathon record is equivalent, if not faster than a 2-h marathon for men (3) is consistent with our recent commentary (see Ref. 4). It is important to examine a larger continuum of distance running events to fully appreciate the underlying mechanisms for sex differences in running performance. Ultramarathons include any distance greater than the traditional marathon and have been rapidly growing in popularity among running enthusiasts. The official world record for the 100-km road race is 6:33:11 for women vs. 6:13:33 for men, a difference of only 5% (i.e., one-half the sex difference for the marathon). In fact, it is not uncommon for women to be among the top finishers, and in some cases, winning ultramarathon races against men. There is no doubt that aerobic capacity, lactate threshold, and running economy are critical determinants of performance as suggested by Hunter et al. (3). However, in the absence of compelling data, it may be premature to dismiss the potential influence of sex differences in substrate utilization (5) and skeletal muscle fatigue resistance. Increasing the rate of fat oxidation will increase exercise endurance by sparing muscle glycogen (2). Indeed, some have hypothesized that this may partially explain the greater fatigue resistance in female ultramarathon runners compared with males (1). These distinct sex differences in physiology may explain, at least in part, why the performance gap tends to decrease with increasing distance and why, in relative terms, Radcliffe’s marathon performance is so impressive compared with the men’s record.

REFERENCES


Jordan A. Guenet
Centre for Heart Lung Innovation and Department of Physical Therapy
University of British Columbia and St. Paul’s Hospital
Vancouver, BC, Canada

UNDERSTANDING MENTAL FATIGUE AND PERCEPTION OF EFFORT TO UNDERSTAND ENDURANCE PERFORMANCE

TO THE EDITOR: In a recent Viewpoint, Hunter et al. (2) suggested that Paula Radcliffe’s world record (2 h 15 min 25 s) set in 2003 is at least equivalent to a 2-h marathon for men. According to the authors, some aspects of Radcliffe’s physiology (e.g., \( \text{VO}_2\text{max}, \) lactate threshold, and running economy) may explain her performance.

We hereby propose that resistance to fatigue may be an additional factor to consider. Fatigue is a multifactorial phenomenon including both physical and mental components. Sex differences in resistance to physical fatigue have been well investigated, demonstrating that there is a greater resistance to physical fatigue in women under certain conditions (1). Interestingly, to date, no study investigating sex differences in resistance to mental fatigue exists. However, as mental fatigue is also known to impair endurance performance (3, 4) through a higher-than normal perception of effort (5), it is crucial that future studies investigate whether women could present a greater resistance to mental fatigue compared with men. If so, this would help us understand why so far only women have broken the equivalent 2-h marathon barrier.

Furthermore, understanding mechanisms of mental fatigue and how perception of effort can be altered in the absence of physiological alterations (5) could lead to improving training and rehabilitation methods in the future. Indeed, increasing resistance to mental fatigue and understanding cortical substrates of perceived exertion could help to increase workload used in training and rehabilitation. Therefore, future research investigating underlying mechanisms of mental fatigue and perception of effort would benefit both athletic and clinical populations.

REFERENCES

ARE FEMALE PERFORMANCES IN OTHER OLYMPIC DISTANCE RUNNING EVENTS EQUIVALENT TO PAULA RADCLIFFE’S?

TO THE EDITOR: We would agree with Hunter et al.’s conclusions (1), but the question could be posed if other female Olympic running performances are as outstanding as that of Paul Radcliffe. If a similar analysis to that of the authors is repeated on other athletes’ performances, Florence Griffith-Joyner (100 m) and Marita Koch (400 m) would both emerge as accomplished women’s world records (WR) equivalent or better than those of the men.

First, the sex differences in the 100 m (9.5%) and 400 m (10.2%) WR are analogous with, or better than, the sex difference in marathon (10.1%). In other Olympic running distances, sex differences ranged between 11.2% and 12.4%.

Second, based on the Mercier score (2), Hunter et al. (1) proposed that the women’s WR by Radcliffe is equivalent to the 2-h barrier for men and below the men’s WR (2:02:57). We note that the 10’49 performed by Florence Griffith-Joyner in the 100 m is equivalent to 9’59 for men, close to the WR of Usain Bolt (9’58), and the 47’6 performed by Marita Koch in the 400 m is equivalent to 42’55 for men, well below the WR by Michael Johnson (43’18).

Finally, unlike Hunter et al.’s (1) analysis, using publicly available data (3) we calculated the relative time of the 100th best performer and compared it with the corresponding WR for each sex and three distances. We found that the differences were relatively small in the 100 m (men: 95.8% vs. women: 95.1%) but more pronounced in the 400 m (men: 96.7% vs. women: 94.8%) and marathon (men: 97.0% vs. women: 94.4%).

In conclusion, using a similar approach to Hunter et al. (1) we suggest that Florence Griffith-Joyner and Marita Koch accomplished a WR at least equal to the men’s WR of Usain Bolt and Michael Johnson, respectively.

REFERENCES

selection process that allows the emergence of individuals with the genetic endowment and will to extend human performance limits. As such, most available evidence is underpowered to make estimations on WRs for men or women, especially in an event like the marathon, where the chances of socioeconomic promotion are much less compared with other sports and make it less attractive. Just as an example, there could be perhaps ~41,000 Spanish individuals with a “near optimal” polygenic profile to excel in the marathon (2). But who of them would like to live the life of a Kalenjin runner or to train like Paula Radcliffe? Current WRs might not reflect the actual limits of our species.

REFERENCES


Alejandro Santos-Lozano1
Nuria Garatachea1,2
Fabian Sanchis-Gomar4
Helios Pareja-Galeano1,3
Carmen Fiuza-Luces1,3
Alejandro Lucia1,3
1Research Institute of Hospital 12 de Octubre (“i/H11001 12”) Madrid, Spain
2Faculty of Health and Sport Sciences University of Zaragoza Huesca, Spain
3European University Madrid, Spain

COMMENTARY ON VIEWPOINT: THE TWO-HOUR MARATHON: WHAT’S THE EQUIVALENT FOR WOMEN?

TO THE EDITOR: Hunter and colleagues (2) raise a provocative question, whose resolution is constrained by the impracticalities of sequential, appropriately focused investigation of the truly elite; that one of the authors accomplished this to a degree over a 15-yr period is noteworthy (3).

The world-record progression in marathon [expressed as mean running velocity (V_R), a proxy of race energy cost] has slowed relative to the pre-1985 linear characteristic (4) more markedly in men than women, with proximate linear regression slopes of 0.424 and 2.295 m/min/yr, respectively (Ward, unpublished). There is also a perceptible sex narrowing between world-record performance year-on-year, the women’s V_R being 89.57% of the men’s in 1998, 89.33% in 1999, 91.50% in 2002, and 92.25% in 2003 (Ward, unpublished). So is it the case, as the authors state, that “sex difference among the best runners has fluctuated minimally over the last 30 years” (2)?

The authors target running economy and critical velocity as determinants of “superior” marathon performance (2). Embedded in these are constructs such as oxygen uptake kinetics and the W’ parameter of the power-duration relationship and how, in men and in women, these might conspire in the face of strategic race-pace fluctuations around critical velocity. And what of potential respiratory-mechanical limitation at high running velocities? A degree of protection for the current women’s world record holder might be afforded by the larger lung volumes conferred by her relative height (1.73 m) (1). In conclusion, if women have indeed attained a “2-h” equivalent marathon, when might this be achieved by men?

REFERENCES