frontiers FOR YOUNG MINDS

HEALTH
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BREAKING THE MARATHON WORLD RECORD WITH YOUR FATHER? THE SUPERPOWER OF LIFELONG ENDURANCE TRAINING

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YOUNG REVIEWER:

CARA

AGE: 12

Are you looking for a training buddy to prepare for your next marathon race? Have you ever considered that your father could be the right person? Would not it be great to cross the finish line side by side and get on the podium together? You probably think that your father is not young enough for such an effort, do not you? We believe that your father may also be capable of exceptional physical performance, despite his older age. In this article, you will see how a father and son (with a 25-year age difference) managed to break the world record for a combined father-and-son marathon in 2019.

Figure 1

The effects of aging in athletes.

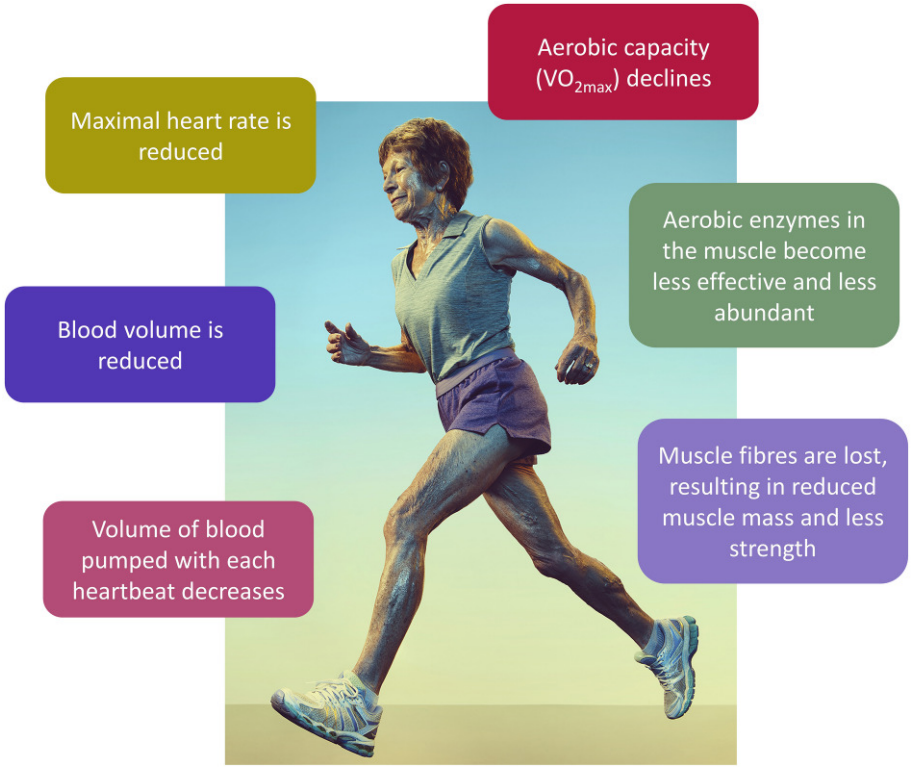

Figure 1

CAN WE MAINTAIN PHYSICAL PERFORMANCE AS WE AGE?

It is well-known that **physical performance** declines with aging (Figure 1). Older people tend to be slower and less powerful, and it is even worse when they do not do much physical activity. Unfortunately, it is not uncommon to see the proportion of time spent watching TV or sitting on the sofa increase with aging. This sedentary lifestyle is associated with gradual changes to the body, including the replacement of muscle mass by fat, cardiorespiratory (heart and lung) problems, and changes to metabolic functions, such as regulation of blood sugar. Consequently, muscle strength and **maximal oxygen consumption (VO_{2max})** decline, making daily activities, such as walking or carrying objects, harder and more painful [1, 2]. VO_{2max} is a good indicator or physical fitness with the higher VO_{2max}, the better for the person. If physical activity is not resumed, a sedentary lifestyle can lead to diseases typically associated with aging, such as osteoporosis (reduction in bone mass), obesity, or cardiorespiratory failure.

But some people choose to stay active as they age. Masters athletes (people older than 40) continue to train intensively and regularly during their entire lives [3]. Some of them train even harder than younger athletes, to try to maintain their performance level for as long as they can. Masters athletes have been taking part in more and more sporting competitions, such as **marathon races** and triathlons

PHYSICAL PERFORMANCE

Ability of an athlete to be strong, fast, and resistant to fatigue. Developing the best possible physical performance is the common goal of athletes to win sporting contests and break records.

MAXIMAL OXYGEN CONSUMPTION (VO_{2MAX})

A measurement that reflects the body's ability to take oxygen into the lungs and transport it to the active muscles during exercise, and the capacity for the muscles to use it to produce energy. VO_{2max} is measured using a respiratory gas analyser connected to a face mask positioned over the athlete's mouth and nose. It is expressed in ml of oxygen breathed in per kilogram of body mass per min (ml/kg/min).

[4, 5]. Researchers have reported a steady increase in the number of masters athletes participating in sporting events over the last 30 years. For example, nowadays more than 50% of men and 40% of women participating in the New York marathon or the Ironman triathlon world championship are masters athletes [4, 5]. Masters athletes not only take part in competitions, but also manage to set record performances in their age groups. In recent years, some exceptional performances have been reported in the marathon, with the current world record set at 2 h 54 min 23 s for the age of 70 [6]. For scientists, masters athletes represent a model of successful aging and a valuable source of insight into our ability to maintain physical performance as we age [3]. In other words, studying masters athletes can help scientists to better understand the effects of aging when there are no complicating factors like sedentary lifestyle or obesity, and can help to find strategies for healthy aging.

MARATHON RACE

Long-distance road running race of 42.195 km, created in 1896 for the original modern Olympic games in Athens, Greece. The official record time is owned by Eliud Kipchoge (from Kenya, Africa) in 2 h 1 min 39 s, performance set on 16 September 2018 at the Berlin Marathon in Germany.

HOW WE STUDIED THE EFFECTS OF LIFELONG ENDURANCE TRAINING

The purpose of our research was to evaluate the physical capacities of two marathon runners, a man and his father. We followed them as they prepared to attempt breaking the world record for a combined father-and-son marathon in Frankfurt, Germany, in October 2019. Through studying these two men, we also wanted to better understand the superpower of lifelong **endurance training**.

ENDURANCE TRAINING

It is a global form of exercise (engaging the whole body) with the goal of improving the fitness and the body's cardiovascular system (heart, lungs, and circulation). Endurance training sessions are generally performed at sub-maximal intensity ($<VO_{2max}$) over long durations (>60 min).

The father was a former Olympic marathoner who competed at the Barcelona Olympic games in 1992. His best marathon performance was 2 h 13 min 59 s, set at the age of 32. At the time of the study, he was 59 and held the age-59 marathon world record of 2 h 30 min 15 s. His son was 35 years old and less experienced (he started to train hard only 4 years earlier), but he could run faster than his father for shorter distances, such as 10 km and half-marathon races. We divided our study into three phases.

Phase 1

Two months prior to the marathon, father and son visited our sport science laboratory at Liverpool John Moores University (Liverpool, United Kingdom) to take a series of physical tests. We measured their body composition (body mass and the proportion of muscle to fat) using a piece of equipment called a DXA scanner. Then, after a quick warm-up, they ran on a treadmill at four different speeds that they could hold without difficulty (15, 16, 17, and 18 km/h), for 5 min each. This test is useful to assess **running economy**, which is the amount of energy used by the body—the lower the energy consumption at each speed, the better the running economy. Each running stage was separated by 5 min of recovery. After this test, the speed of the treadmill was gradually increased every minute, until the athletes could run no more. During these running tests, the athletes wore a chest

RUNNING ECONOMY

It is the energy demand for a given submaximal running speed, and the lower the energy demand the better running economy. It is expressed in ml of oxygen breathed in per kilogram of body mass per kilometer (ml/kg/km).

belt to monitor heart rate and a face mask to monitor their oxygen consumption. When the athletes reached their point of exhaustion, we could determine their VO_{2max}, which is like the engine capacity for a car.

Phase 2

The training routines, including the number of kilometers they ran every week, as well as the dietary habits of the athletes were recorded for the 2 months prior to the marathon. The father ran an average of 180 km per week during this time, while the son ran 140 km per week. They usually did not train together. Most of their training was performed at running speeds slower than their planned marathon pace, but they reached higher speeds during local races (from 5 km to half-marathon) that they entered almost every weekend. Father and son both ate the same basic diet, rich in carbohydrates. It was composed of porridge oats with fresh and dried fruits for breakfast, a whole-grain sandwich for lunch, and potatoes, rice, or pasta accompanied mostly by chicken for dinner.

Phase 3

On Sunday 27th October 2019, father and son participated in the Frankfurt marathon. Their running paces were collected during the entire marathon, using a small chip attached to one of their running shoes. We also measured the number of energy bars, gels, or drinks they ate or drank during the race.

HOW DID FATHER AND SON PERFORM?

Father and son achieved their goal by breaking the world record for the combined father-and son-marathon by almost 3 min (Figure 2). The father completed the marathon in 2 h 27 min 52 s and the son finished in 2 h 31 min 30 s, for a combined time of 4 h 59 min 22 s, which was 2 min 50 s faster than the previous combined father-and-son marathon world record. The father also broke his own age-59 world record by 2 min 23 s.

Their exceptional performances could be explained by several factors measured during the physical tests conducted in our laboratory. During the test in which they ran until exhaustion, father and son reached high VO_{2max} values compared to the average values for most people of their ages. The father's VO_{2max} was 65 ml/kg/min and the son's was 67 ml/kg/min. The average values reported for people of the same age are 31 and 40 ml/kg/min, respectively, which is much lower than our athletes [7]. A high VO_{2max} is a clear asset for endurance performance and a common characteristic of elite younger endurance runners, with the best marathon runners having a VO_{2max} above 80 ml/min/kg [8]. In addition, running economy, as measured by oxygen uptake at marathon pace, of both the father and son was close to that

Figure 2

Father and son after crossing the finish line of the marathon.

Figure 2

measured in elite young marathon runners. This means our runners could maintain a high running speed during the entire marathon. Both father and son had low body mass (61.2 and 67.4 kg, respectively) and a low percentage of body fat (10.9 and 12.7%, respectively), which likely contributed to their good running economy—the lower the body mass to carry, the lower the energy required to run.

Our findings suggest that both the father and son could further improve their world record by optimizing the nutrition they take in during the race, as the father only ate two energy gels (at mid-race and 32 km) with water, while the son ate one energy gel with a few sips of sports drink. Eating plenty of carbohydrates in the form of drinks and gels is very important during such a long race, to provide a constant flow of energy to the muscles [9]. With more experience, the son might also be able to improve his time with a better control of his pacing during the race. We noticed that the father used a steady running pace during the entire race, whereas the son ran a fast first half followed by a slower second half (Figure 3). Recent studies and the observations of elite athletes tell us that the best pacing strategy was that used by the father [10].

Beyond the combined father-and-son marathon world record, the most astonishing result was the exceptional performance of the father. The father crossed the finish line before his son (he finished 76th overall and his son finished 115th). The father maintained an impressively high intensity during the entire marathon, despite his age. At his marathon speed, his oxygen consumption was close to ~91% of his maximal capacity (VO_{2max}). A similar capacity was also observed in the master marathon runner who currently holds the age-70 world record [6]. These values are the highest ever observed for the marathon at any age, even including elite young marathon runners. These data show that masters athletes are able to extend the limits of human performance.

Figure 3

Pacing strategy of the father (in blue) and son (in red) every 5 km of the marathon. The son's running speed was slightly higher than his father up to the 30th km and then dropped drastically until the end of the race. In contrast, the father maintained a steady running pace during the entire race, which allowed him to deliver the best performance in the marathon for his age group.

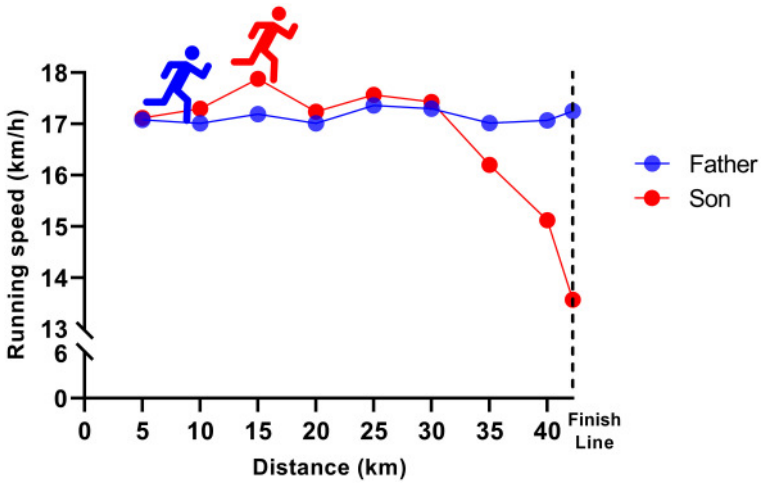

Figure 3

CONCLUSION

Overall, our study provides proof that masters athletes can maintain an exceptional level of physical performance, despite the aging process. It is also important to mention that you do not need to train as much as our athletes to benefit from the superpower of physical training. We hope that you will bear in mind that keeping an active lifestyle and continuing to train as you get older will help you to stay healthier for your entire life. In our study we focused on the marathon, because it is the most common endurance event in running, and all age groups compete together in the same event. Future studies should focus on other types of sports, such as swimming or cycling, in which the body weight is supported (by the water or the bike, for example) to verify if exceptional performances, such as those we observed in our study are possible in additional sports.

ORIGINAL SOURCE ARTICLE

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CONFLICT OF INTEREST: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

YOUNG REVIEWER

CARA, AGE: 12

Hello, my name is Cara and I am 12 years old. My favorite hobbies include swimming, cooking, and reading. My favorite books include Harry Potter by J. K. Rowling and Am I Normal Yet? by Holly Bourne.

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I am a Professor in exercise physiology at the Faculty of Sport Sciences of Dijon, University of Bourgogne (France). My laboratory is part of the National Institute for Health and Medical Research (INSERM CAPS). I am interested in the age-related changes in endurance performance, such as marathon and triathlon. I also perform research on how physical exercise affects the muscular and neural systems. Outside of work, I love swimming, cycling, running, and taking part in triathlon races. *romuald.lepers@u-bourgogne.fr