Running Performance, Nationality, Sex, and Age in the 10-km, Half-Marathon, Marathon, and the 100-km Ultramarathon IAAF 1999–2015

Pantelis T. Nikolaidis,[1] Vincent O. Onywera,[2] and Beat Knechtle[3,4]

[1]Exercise Physiology Laboratory, Nikaia, Greece; [2]Department of Recreation Management and Exercise Science, Kenyatta University, Nairobi, Kenya; [3]Institute of Primary Care, University of Zurich, Zurich, Switzerland; and [4]Health Center St. Gallen, St. Gallen, Switzerland

Abstract

Nikolaidis PT, Onywera VO, and Knechtle B. Running performance, nationality, sex, and age in the 10-km, half-marathon, marathon, and the 100-km ultramarathon IAAF 1999–2015. *J Strength Cond Res* 31(8): 2189–2207, 2017—The aim of this study was to examine the performance of the world's best runners in the 10-km, half-marathon, marathon, and 100-km races by age, sex, and nationality during 1999–2015, using data from the International Association of Athletics Federations (IAAF). A total of 38,895 runners (17,136 women and 21,759 men) were evaluated, with 2,594 (1,360 women and 1,234 men) in the 10-km; 11,595 (5,225 women and 6,370 men) in the half-marathon; 23,973 (10,208 women and 13,765 men) in the marathon; and 733 (343 women and 390 men) in 100-km events. Most runners in the 10-km event (women 40%, men 67%) and the half-marathon (women 30%, men 57%) were Kenyans. In the marathon, most female and male runners were Ethiopians (women 17%, men 14%) and Kenyans (women 15%, men 43%), respectively. In the 100-km event, most runners were Japanese (20% women, and 80% men). Women were older than the men in the 10-km (32.0 ± 6.0 vs. 25.3 ± 4.3 years, $p < 0.001$), half-marathon (27.5 ± 4.7 vs. 25.9 ± 4.1 years, $p < 0.001$), and marathon events (29.5 ± 5.5 vs. 29.1 ± 4.3 years, $p < 0.001$), but not in 100-km event (36.6 ± 6.1 vs. 35.9 ± 5.5 years, $p = 0.097$). Men were faster than the women in the 10-km (28:04 ± 0:17 vs. 32:08 ± 0.31 (minutes:seconds), $p < 0.001$), half-marathon (1:01:58 ± 0:00:52 vs. 1:11:21 ± 0:01:18 (hours:minutes:seconds), $p < 0.001$), marathon (2:13:42 ± 0:03:01 vs. 2:35:04 ± 0:05:21 (hours:minutes:seconds), $p < 0.001$), and 100-km events (6:48:01 ± 0:11:29 vs. 7:53:51 ± 0:16:37 (hours:minutes:seconds), $p < 0.001$). East Africans were not the fastest compared with athletes originating from other countries where only the Ethiopian men were faster than all other men in the marathon. In summary, (a) in the 10-km, half-marathon and marathon events, most runners were from Kenya and Ethiopia, and from Japan and Russia in the 100-km event; (b) women were older than the men in all distance events except the 100-km event; (c) men were the fastest in all distances; and (d) Ethiopian men were faster than all other men in the marathon.

Key Words origin, East Africa, Japan, athlete, elite level

Introduction

Knowing the optimum age for best athletic performance is of great importance to athletes and coaches in planning an athlete's career. It seems that the age for peak athletic performance increases with an increase in the duration or distance of the event (1). It has been shown in ultramarathoners competing in time-limited races from 6 hours to 10 days that the age of peak ultramarathon performance increased with an increase in the duration of the event (15).

The ages for the fastest runners competing in the half-marathon, marathon, and 100-km ultramarathon races have been reported for different and selected samples (i.e., recreational and elite levels). An analysis of 125,894 female and 328,430 male recreational half-marathoners competing between 1999 and 2014 in all half-marathons held in Switzerland showed that women (41.4 ± 10.6 years) were in the same age bracket as the men (41.3 ± 10.3 years) (14). In addition, an analysis of the ages of 10,205 female and 43,489 recreational male marathoners competing between 1999 and 2014 in all marathon races held in Switzerland found that women were in the same age bracket (42.2 ± 10.6 years) as the men (42.1 ± 10.4 years) (14).

In the marathon and ultramarathon races, the performance levels of the athletes seem to be of crucial importance, and are linked with the age for peak running performance. In elite

Address correspondence to Dr. Beat Knechtle, beat.knechtle@hispeed.ch.

31(8)/2189–2207

Journal of Strength and Conditioning Research

Table 1. Coefficients (C) and standard errors (*SE*) from multivariate regression models for age by nationality in women and men.

	C	*SE*	*p*
10 km			
Sex (=female)	5.20	0.61	<0.001
Nationality	0.07	0.02	0.001
Interaction sex × nationality	0.07	0.03	0.008
21.1 km			
Sex (=female)	−1.61	0.26	<0.001
Nationality	0.01	0.00	0.174
Interaction sex × nationality	0.08	0.01	<0.001
42.2 km			
Sex (=female)	−1.87	0.16	<0.001
Nationality	0.01	0.00	<0.001
Interaction sex × nationality	0.04	0.00	<0.001
100 km			
Sex (=female)	−1.76	1.23	0.152
Nationality	−0.16	0.04	<0.001
Interaction sex × nationality	0.12	0.06	0.033

marathoners, their ages were considerably lower compared with recreational runners. When the ages of the first 5 placed women and men competing in the 7 marathons of the "World Marathon Majors Series" were analyzed, women (29.8 ± 4.2 years) were older than men (28.9 ± 3.8 years) in 2 of the 7 marathons (10). When running times of the top 10 men and women competing in the "New York City Marathon" were analyzed at 1-year intervals from 18 to 75 years for the 2010 and 2011 races, the lowest race time was obtained at 27 years in men and at 29 years in women (16). When the ages of annual fastest women and men in all 100-km ultramarathons held worldwide between 1960 and 2012 were analyzed for 148,017 finishes (i.e., 18,998 women and 129,019 men), the ages of the fastest women and men were both ~35 years (4). For the 6,862 female and 29,094 male 100-mile ultramarathoners competing between 1998 and 2011, the ages of the annual top 10 fastest were 39.2 ± 6.2 years for women and 37.2 ± 6.1 years for men with no difference in sex (24).

Table 2. Coefficients (C) and standard errors (*SE*) from multivariate regression models for the race time by nationality in women and men.

	C	*SE*	*p*
10 km			
Sex (=female)	14,529.83	181.01	<0.001
Nationality	4.57	6.42	0.477
Interaction sex × nationality	4.82	8.02	0.548
21.1 km			
Sex (=female)	560.17	3.75	<0.001
Nationality	0.18	0.06	0.003
Interaction sex × nationality	0.09	0.09	0.304
42.2 km			
Sex (=female)	1,263.00	7.99	<0.001
Nationality	0.68	0.10	<0.001
Interaction sex × nationality	0.30	0.13	0.021
100 km			
Sex (=female)	4,037.16	176.44	<0.001
Nationality	−6.03	5.57	0.279
Interaction sex × nationality	−4.28	7.99	0.592

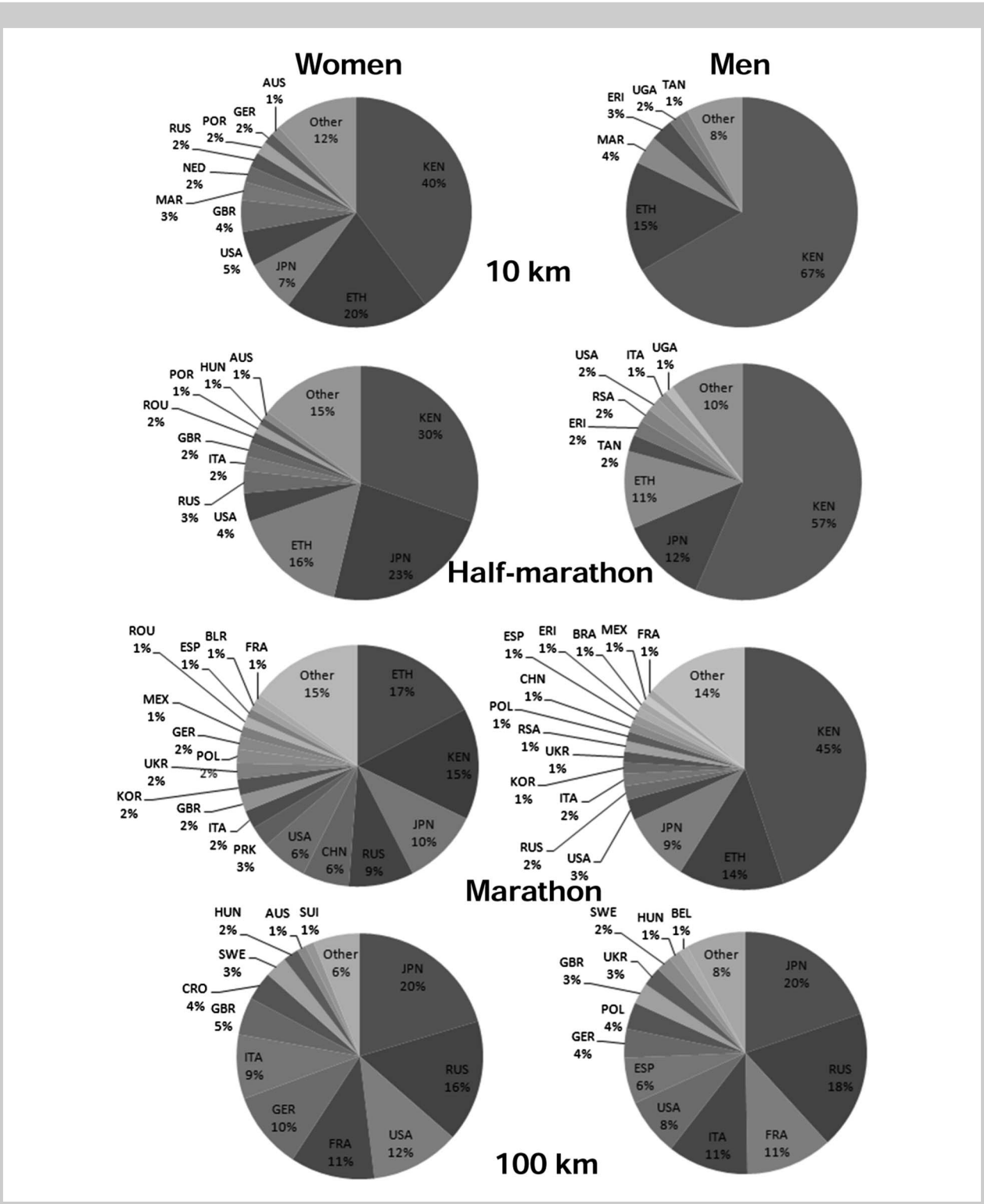

Figure 1. Nationality of runners by race, distance, and sex. Countries with less than 1% frequency were included in "other."

The place of origin of an athlete seems to be of importance when reckoning the age of peak running performance. The dominance of East African runners is well known (21,22,25). In recent years, the number of East African runners competing at world-class levels has considerably increased. Regarding the top 100 male and

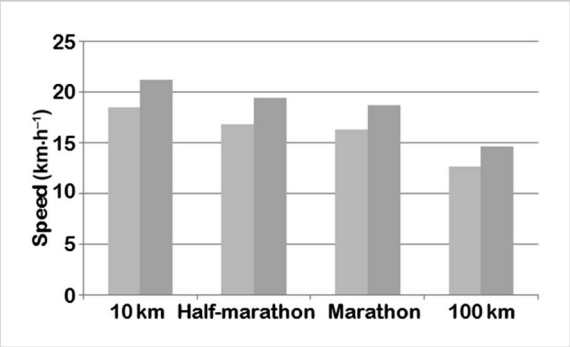

Figure 2. Running speed by race and sex. Women are depicted on the left, and men on the right, for each race distance.

female athletes from 100 m to the marathon between 1996 and 2012, the share of male and female athletes from East Africa increased from 32 to 65.7%, and 9 to 39%, respectively (20). Reasons for the dominance of East African athletes in running are genetic predisposition, favorable diet, living and training at high altitude, specific physiological characteristics, a high running economy, and a specific sociocultural background (17,18,21,29). Both elite Ethiopian (25) and Kenyan (22) runners are from a distinctive environmental background in terms of geographical distribution and ethnicity, and were accustomed to travel further to and from school, mostly by running.

The aspect of age and performance of African, and especially East African runners, has been investigated in athletes competing at recreational and international levels. In recreational half-marathoners competing between 2000 and 2010 in Switzerland, men who were non-African runners (31.1 ± 6.4 years) were older than African runners (26.2 ± 4.9 years) (2). Among women, however, there was no difference in age between non-African (31.0 ± 7.0 years) and African (26.7 ± 6.0 years) half-marathoners (2). Similarly to half-marathoners, differences were found for African and non-African marathoners competing at recreational levels in races held in Switzerland. Among men, non-African marathoners (33.0 ± 4.8 years) were older than African marathoners (28.6 ± 3.8 years). Also in women, non-African marathoners (31.6 ± 4.8 years) were older compared with African marathoners (27.8 ± 5.3 years) (2). A recent study further differentiated East African runners competing in half-marathons and marathons at recreational levels. When 508,108 athletes (i.e., 125,894 female and 328,430 male half-marathoners, and 10,205 female and 43,489 male marathoners) originating from 126 countries, and competing between 1999 and 2014 in all road-based half-marathons and marathons held in Switzerland were analyzed, women and men from Ethiopia and Kenya achieved the fastest race times, and were the youngest in both half-marathons and marathons despite accounting for < 0.1% in formats of races (13). Results for East African marathoners competing at international levels were very similar. When the age of peak marathon performance was investigated for the annual top 100 women and men competing in 4 races of the "World Marathon Majors" (Boston, Berlin, Chicago, and New York) and the "Stockholm Marathon" between 2000 and 2014, female (26.5 ± 2.0 years) and male (29.0 ± 5.0 years) marathoners from Ethiopia were the youngest and the fastest (11).

These data show that the optimum age for the best running performances in half-marathon, marathon, and ultramarathon distances differs when different samples were analyzed. Furthermore, the ages of the fastest 10-km runners have not been investigated to date. In this actual study, we analyzed the ages and race times of the world's best female and male runners competing in road running races in the 10-km, half-marathon, marathon, and 100-km ultramarathon for women and men from 1999 to 2015 that were listed in the International Association of Athletics Federations (IAAF) record lists. On the basis of the existing data, we hypothesized, first, that the fastest women and men would originate from East Africa in the 10-km, half-marathon, and marathon races, but not in the 100-km ultramarathon. Second, we hypothesized that East African runners (i.e., from Ethiopia and Kenya) would be the youngest.

Methods

Experimental Approach to the Problem

To test our hypotheses, all women and men who were listed in the IAAF website at www.iaaf.org between 1999 and 2015 in the 10-km, half-marathon, marathon, and 100-km ultramarathon in outdoor road running were considered. Sex, age, country, and performance (hours:minutes:seconds) of each athlete were recorded and analyzed.

Subjects

The subjects for this study were selected from the website of the IAAF at www.iaaf.org. The IAAF has a database of all the best results achieved in athletics worldwide. We retrieved from their website the results for road running in the 10-km, half-marathon, marathon, and 100-km ultramarathon for women and men from 1999 to 2015. All procedures used in the study were approved by the Institutional Review Board of Kanton, St. Gallen, Switzerland, with a waiver of the requirement for informed consent of the participants given the fact that the study involved the analysis of publicly available data.

Procedures

A total of 38,895 runners (i.e., 17,136 women and 21,759 men) were considered in this study: 2,594 (i.e., 1,360 women and 1,234 men) in the 10 km; 11,595 (i.e., 5,225 women and 6,370 men) in the half-marathon; 23,973 (i.e., 10,208 women and 13,765 men) in the marathon; and 733 (i.e., 343 women

Table 3. Nationality, number of participants, age, and 10-km race time in women, sorted in alphabetical order of the country.

Nationality	*n*	Age (y)	Time (min:s)
Algeria	2	36 ± 0	32:35 ± 0:31
Australia	17	33.94 ± 3.63	32:16 ± 0:28
Austria	1	45	31:45
Burundi	5	31 ± 0	32:20 ± 0:22
Belgium	2	43.5 ± 2.12	32:15 ± 0:18
Brazil	2	36 ± 7.07	32:34 ± 0:03
Brunei	11	30.45 ± 6.98	32:23 ± 0:15
Canada	5	32.6 ± 1.34	32:12 ± 0:18
China	2	33.5 ± 3.54	32:23 ± 0:20
Croatia	1	31	32:45
Eritrea	5	26.4 ± 2.61	32:26 ± 0:12
Ethiopia	276	28.01 ± 4.48	32:06 ± 0:27
Finland	1	36	32:41
France	12	37.67 ± 6.24	32:19 ± 0:19
Great Britain	60	36.53 ± 6.65	32:14 ± 0:36
Germany	21	39.48 ± 4.29	32:08 ± 0:30
Hungary	7	37.29 ± 1.89	32:05 ± 0:26
Ireland	5	43.4 ± 5.81	31:42 ± 0:37
Italy	12	36.25 ± 3.11	32:16 ± 0:14
Japan	99	31.64 ± 5.34	32:32 ± 0:22
Kenya	541	31.24 ± 5.19	32:01 ± 0:32
Latvia	8	39 ± 0	32:01 ± 0:25
Morocco	35	34.4 ± 5.34	32:01 ± 0:31
Mexico	2	35 ± 0	32:42 ± 0:09
The Netherlands	31	39.06 ± 3.41	31:38 ± 0:30
Norway	7	27.88 ± 7.56	32:06 ± 0:33
New Zealand	12	33 ± 3.05	32:06 ± 0:26
Poland	4	35.75 ± 6.45	32:34 ± 0:17
Portugal	25	33.28 ± 4.04	32:20 ± 0:18
Romania	12	43.92 ± 1.24	32:13 ± 0:34
Republic of South Africa	7	37.86 ± 8.69	32:14 ± 0:29
Russia	28	36.25 ± 6.20	32:29 ± 0:24
Serbia and Montenegro	2	38 ± 0	32:07 ± 0:00
Serbia	1	38	32:04
Spain	9	35.11 ± 2.52	32:36 ± 0:15
Sweden	2	30.5 ± 6.36	32:37 ± 0:04
Tanzania	1	31	32:58
Turkey	7	31.57 ± 2.44	31:54 ± 0:31
United Arab Emirates	1	24	32:20
Uganda	5	26.8 ± 2.68	32:22 ± 0:18
Ukraine	5	37.2 ± 6.26	32:05 ± 0:31
United States	67	34.51 ± 6.70	32:19 ± 0:26
Uzbekistan	1	40	33:00
Zimbabwe	1	32	33:00
Total	1,360	32.03 ± 6.04	32:08 ± 0:31

and 390 men) in the 100 km. The cutoff times to be included in this list were 33:00 (minutes:seconds) for women, and 29:00 (minutes:minutes) for men in the 10-km event. For the half-marathon, the cutoff times were 1:13:00 (hours:minutes:seconds) for women, and 1:03:00 (hours:minutes:seconds) for men. In the marathon, the cutoff was 2:45:00 (hours:minutes:seconds) for women, and 2:19:00 (hours:minutes:seconds) for men. In the 100-km event, the cutoff was 8:30:00 (hours:minutes:seconds) for women, and 7:10:00 (hours:minutes:seconds) for men.

Statistical Analyses

The statistical software IBM SPSS v.20.0 (SPSS, Chicago, IL) was used to carry out all statistical analyses. Descriptive statistics (mean and *SD* of the mean) were used for all data. To study differences in the running performance and

Table 4. Nationality, number of participants, age, and 10-km race time in men, sorted in alphabetical order of the name of the country.

Nationality	*n*	Age (y)	Time (min:s)
Algeria	1	23	28:08
Australia	4	26.75 ± 2.5	28:11 ± 0:12
Austria	2	29 ± 1.41	28:12 ± 0:03
Burundi	5	21.6 ± 2.30	28:21 ± 0:04
Brazil	6	31.5 ± 1.87	28:10 ± 0:15
Brunei	2	29.5 ± 0.71	27:50 ± 0:19
Eritrea	39	24.95 ± 4.31	28:02 ± 0:16
Ethiopia	191	23.30 ± 4.45	28:06 ± 0:17
France	3	31.33 ± 2.08	28:27 ± 0:04
Great Britain	9	26.89 ± 2.57	28:20 ± 0:26
Germany	3	29.67 ± 6.66	28:03 ± 0:07
Ireland	1	34	28:30
Italy	2	26 ± 4.24	28:24 ± 0:07
Japan	6	24 ± 2.76	28:13 ± 0:08
Kenya	822	25.31 ± 3.98	28:02 ± 0:18
Libya	2	30 ± 1.41	28:06 ± 0:09
Morocco	50	28.3 ± 3.81	28:12 ± 0:14
Mexico	1	32	28:09
The Netherlands	2	24 ± 0	28:13 ± 0:07
New Zealand	1	26	28:10
Qatar	9	26.33 ± 3.20	28:06 ± 0:09
Republic of South Africa	6	26.83 ± 2.64	28:10 ± 0:22
Russia	1	37	28:22
Rwanda	3	27 ± 1	27:58 ± 0:21
Spain	5	32.4 ± 3.58	28:16 ± 0:15
Switzerland	1	32	28:40
Sweden	1	29	28:12
Tanzania	15	24.4 ± 3.20	28:09 ± 0:13
Turkey	1	21	28:17
Uganda	20	22.45 ± 2.74	28:08 ± 0:10
Ukraine	6	33.67 ± 3.72	28:16 ± 0:12
United States	11	29.45 ± 4.95	28:14 ± 0:17
Zimbabwe	3	27 ± 4.36	28:20 ± 0:15
Total	1,234	25.27 ± 4.27	28:04 ± 0:17

age by sex and nationality from 1999 to 2015, we used a mixed-effects regression model with runners as the random variables, where sex and nationality were assigned as fixed variables (Tables 1 and 2). In addition, we examined the variation of performance and age by calendar year using a mixed-effects regression model with runners as random variables, and sex and calendar year as the fixed variables. We examined interaction effects among these fixed variables. Akaike information criterion was used to select the final model. In addition, we used a 1-way analysis of variance with post hoc Bonferroni test to examine differences among nationality groups for running performance and age. The effect size was examined by eta square (η^2), classified as trivial ($\eta^2 < 0.01$), small ($0.01 \leq \eta^2 < 0.06$), medium ($0.06 \leq \eta^2 < 0.14$), and large ($\eta^2 \geq 0.14$) (7). Sex differences in performance and age were examined by *t*-test, and the effect size of these differences was evaluated by Cohen's *d* as $d \leq 0.2$, trivial; $0.2 < d \leq 0.6$, small; $0.6 < d \leq 1.2$, moderate; $1.2 < d \leq 2.0$, large; and $d > 2.0$, very large (7,9). Pearson correlation coefficient *r* was used to examine the relationship between age and race time for each race distance within each sex. The magnitude of *r* was evaluated as trivial ($r < 0.10$), small ($0.10 \leq r < 0.30$), moderate ($0.30 \leq r < 0.50$), large ($0.50 \leq r < 0.70$), very large ($0.70 \leq r < 0.90$), or almost perfect ($r \geq 0.90$) (7,9). Statistical significance was set at alpha = 0.05.

Results

Nationality

The nationalities of the runners varied by sex and race distance (Figure 1). In the 10-km event, most runners were from Kenya and Ethiopia; however, the third nationality was that of Japan among women and Morocco among men. In

Table 5. Nationality, number of participants, age, and half-marathon race time in women, sorted in alphabetical order of the name of the country.

Nationality	*n*	Age (y)	Time (h:min:s)
Algeria	18	30.44 ± 3.85	1:11:34.83 ± 0:01:06.97
Argentina	1	29	1:12:42.00
Australia	51	29.47 ± 3.86	1:11:31.14 ± 0:01:15.59
Austria	5	33.6 ± 3.13	1:12:24.60 ± 0:00:27.40
Azerbaijan	3	19.67 ± 1.53	1:09:56.67 ± 0:01:22.59
Burundi	6	29.33 ± 1.63	1:10:49.17 ± 0:01:28.79
Belgium	9	33.89 ± 3.69	1:11:14.33 ± 0:01:27.41
Bosnia and Herzegovina	1	27	1:12:55.00
Belarus	7	28.57 ± 3.78	1:11:59.43 ± 0:00:27.22
Brazil	3	32.33 ± 4.16	1:12:08.00 ± 0:00:15.71
Brunei	25	26.79 ± 4.21	1:11:01.68 ± 0:01:08.14
Canada	18	31.67 ± 3.12	1:12:03.22 ± 0:00:39.49
China	46	24.2 ± 3.65	1:11:50.89 ± 0:01:01.99
Colombia	3	30.67 ± 1.53	1:11:17.33 ± 0:01:09.40
Croatia	11	29.7 ± 1.06	1:10:59.27 ± 0:01:15.91
Cuba	2	31 ± 1.41	1:11:12.00 ± 0:01:43.23
Czech Republic	2	30 ± 1.41	1:12:15.00 ± 0:00:05.65
Denmark	6	32.83 ± 6.11	1:12:19.83 ± 0:00:45.44
Eritrea	12	21.18 ± 2.56	1:11:56.17 ± 0:00:55.92
Estonia	2	32.5 ± 3.54	1:12:45.50 ± 0:00:02.12
Ethiopia	836	24.51 ± 3.62	1:11:07.16 ± 0:01:22.56
France	44	33.39 ± 4.05	1:11:40.70 ± 0:01:10.53
Great Britain	102	32.42 ± 4.6	1:11:36.06 ± 0:01:11.04
Germany	45	33.24 ± 4.21	1:11:14.13 ± 0:01:18.12
Hong Kong	1	27	1:12:58.00
Hungary	52	29.62 ± 2.92	1:11:24.50 ± 0:01:01.69
India	4	27.75 ± 3.5	1:11:45.50 ± 0:00:48.83
Ireland	8	33.13 ± 3.44	1:11:28.75 ± 0:00:52.06
Italy	105	31.7 ± 4.23	1:11:35.87 ± 0:01:15.76
Japan	1,222	25.75 ± 4	1:11:38.85 ± 0:01:01.38
Kenya	1,584	27.23 ± 3.95	1:11:02.77 ± 0:01:26.64
Kyrgyz Republic	1	28	1:12:29.99
Latvia	21	31.67 ± 4.97	1:11:19.62 ± 0:01:20.42
Lithuania	10	27 ± 3.16	1:12:08.70 ± 0:00:48.62
Morocco	11	30.18 ± 4.33	1:11:49.91 ± 0:01:04.50
Mexico	42	29.43 ± 4.52	1:11:45.24 ± 0:00:58.12
Namibia	12	29.92 ± 2.39	1:11:54.67 ± 0:00:41.15
The Netherlands	33	30.64 ± 3.71	1:11:02.64 ± 0:01:37.93
Norway	12	29.75 ± 5.64	1:11:48.83 ± 0:01:09.45
North Korea	4	22.25 ± 4.57	1:12:31.50 ± 0:00:26.04
New Zealand	27	31.11 ± 2.19	1:10:36.48 ± 0:01:34.45
Peru	7	28.67 ± 1.21	1:12:28.29 ± 0:00:31.11
Poland	29	32.14 ± 3.6	1:12:12.86 ± 0:00:34.95
Portugal	67	30.25 ± 3.53	1:11:19.90 ± 0:01:00.04
Puerto Rico	1	27	1:12:48.00
Romania	78	32.21 ± 3.93	1:11:10.29 ± 0:01:18.90
Republic of South Africa	25	30.36 ± 3.96	1:11:37.92 ± 0:01:27.45
Russia	160	32.12 ± 4.76	1:11:36.31 ± 0:01:01.09
Rwanda	2	27 ± 7.07	1:12:21.50 ± 0:00:31.82
Serbia and Montenegro	10	25.4 ± 2.84	1:11:36.80 ± 0:01:25.49
Slovenia	15	38.33 ± 1.72	1:11:45.47 ± 0:01:10.67
Serbia	5	30.8 ± 1.3	1:12:11.20 ± 0:00:32.07
South Korea	16	25.81 ± 4.64	1:12:03.38 ± 0:00:34.98
Spain	29	32.76 ± 3.39	1:11:59.45 ± 0:00:48.26
Switzerland	4	34.5 ± 0.58	1:12:13.25 ± 0:00:44.13

(continued on next page)

Sweden	17	31.59 ± 2.21	1:11:28.41 ± 0:00:39.43
Tanzania	21	27.2 ± 5.51	1:11:42.95 ± 0:01:01.67
Turkey	17	29.18 ± 4.08	1:11:24.12 ± 0:01:31.25
Uganda	6	23.17 ± 2.64	1:11:49.00 ± 0:00:45.93
Ukraine	24	29.96 ± 3.34	1:11:50.96 ± 0:01:01.93
United States	205	31.19 ± 4.7	1:11:41.78 ± 0:01:10.63
Uzbekistan	1	32	1:10:38.00
Zimbabwe	7	29.43 ± 4.89	1:12:00.14 ± 0:00:29.37
Total*	5,225	27.52 ± 4.75	1:11:21.89 ± 0:01:17.36

*Total number of participants included also 72 cases which did not report nationality.

Table 6. Nationality, number of participants, age, and half-marathon race time in men, sorted in alphabetical order of the name of the country.

Nationality	*n*	Age (y)	Time (h:min:s)
Algeria	12	27.67 ± 2.46	1:02:16.42 ± 0:00:29.04
Angola	2	32.5 ± 0.71	1:02:41.50 ± 0:00:04.95
Australia	16	28.94 ± 2.59	1:02:21.44 ± 0:00:43.13
Austria	3	32 ± 3	1:02:20.33 ± 0:00:33.20
Azerbaijan	1	24	1:02:03.00
Burundi	9	25.44 ± 7.38	1:02:35.89 ± 0:00:22.43
Belgium	7	32.71 ± 2.98	1:01:50.14 ± 0:00:39.36
Belarus	1	35	1:02:56.00
Botswana	1	29	1:02:32.99
Brazil	25	31 ± 3.87	1:02:14.84 ± 0:00:46.09
Brunei	12	27.33 ± 5.99	1:02:11.67 ± 0:00:33.88
Canada	5	27.2 ± 1.1	1:02:19.20 ± 0:00:32.10
China	4	18.75 ± 2.5	1:02:47.00 ± 0:00:10.19
Denmark	2	23.5 ± 0.71	1:02:36.00 ± 0:00:16.97
Eritrea	137	25.73 ± 4.35	1:01:30.98 ± 0:01:05.26
Estonia	1	32	1:03:00.00
Ethiopia	674	24.91 ± 4.18	1:01:47.82 ± 0:00:56.97
Finland	2	31.5 ± 2.12	1:02:42.50 ± 0:00:10.60
France	43	30.28 ± 3.59	1:02:15.49 ± 0:00:35.72
Great Britain	13	29.23 ± 4.32	1:02:02.69 ± 0:01:04.40
Germany	5	31 ± 2.74	1:02:35.00 ± 0:00:15.60
Ireland	7	28.29 ± 2.06	1:01:56.29 ± 0:00:29.11
Italy	87	29.28 ± 3.51	1:02:17.08 ± 0:00:37.01
Japan	768	24.97 ± 3.44	1:02:28.53 ± 0:00:27.04
Kenya	3,602	25.82 ± 6.15	1:01:50.30 ± 0:00:54.34
Libya	3	30 ± 1.73	1:02:42.33 ± 0:00:08.96
Lesotho	2	27	1:02:17.00 ± 0:00:49.49
Morocco	27	29.04 ± 4.64	1:02:13.56 ± 0:00:33.40
Mexico	17	30.24 ± 2.99	1:02:18.76 ± 0:00:42.46
Namibia	2	32 ± 7.07	1:02:24.00 ± 0:00:33.94
The Netherlands	33	29.64 ± 3.35	1:02:32.33 ± 0:00:24.25
Norway	5	26 ± 4.74	1:02:44.80 ± 0:00:11.16
New Zealand	3	29.67 ± 3.21	1:01:46.33 ± 0:01:43.46
Peru	1	33	1:02:55.00
Philippines	1	30	1:02:58.00
Poland	6	27.17 ± 2.14	1:02:23.67 ± 0:00:27.47
Portugal	29	32.97 ± 3.85	1:02:33.10 ± 0:00:23.44
Qatar	29	25.9 ± 3.23	1:02:00.03 ± 0:00:40.40
Romania	1	28	1:01:54.00

Republic of South Africa	117	28.03 ± 3.52	1:02:10.56 ± 0:00:34.37
Russia	7	26.29 ± 3.5	1:02:37.57 ± 0:00:23.64
Rwanda	29	27.36 ± 4.24	1:01:51.24 ± 0:00:51.51
Saudi Arabia	1	39	1:02:58.00
Serbia and Montenegro	1	23	1:02:38.00
Slovenia	1	34	1:02:49.00
Switzerland	5	32.6 ± 3.65	1:02:15.00 ± 0:00:53.55
Slovakia	2	32.5 ± 0.71	1:01:24.50 ± 0:01:18.48
South Korea	1	23	1:02:36.00
Spain	31	31.94 ± 3.49	1:02:18.87 ± 0:00:43.09
Sweden	2	29 ± 5.66	1:02:34.50 ± 0:00:07.77
Tanzania	146	22.81 ± 3.36	1:01:53.25 ± 0:00:48.31
Tunisia	6	27.5 ± 1.38	1:02:20.17 ± 0:00:24.66
Turkey	5	26.4 ± 4.51	1:02:07.60 ± 0:00:45.13
Uganda	77	23.66 ± 2.81	1:02:08.79 ± 0:00:43.87
Ukraine	13	26.54 ± 3.2	1:02:30.31 ± 0:00:20.25
United States	116	28.83 ± 4	1:02:14.27 ± 0:00:39.07
Zambia	1	27	1:03:00.00
Zimbabwe	25	27.8 ± 3.98	1:02:20.36 ± 0:00:44.22
Total*	6,370	26.04 ± 5.48	1:01:58.26 ± 0:00:52.07

*Total number of participants included also 186 cases which did not report nationality.

the half-marathon, most runners were from Kenya, Japan, and Ethiopia. In the marathon, most runners were from these 3 countries as well; nevertheless, the order of the first 2 differed between women and men (Ethiopia and Kenya in women vs. Kenya and Ethiopia in men). In the 100-km ultramarathon, most runners were from Japan and Russia, while the third nationality was the United States among women, and France among men, and with the exception of Japan and the United States, all nationalities with higher than 1% frequency were from Europe.

Running Speed for Sex and Race Distance

The running speed differed between sexes and among the race distances. The running speed was the highest in the 10-km event. Men were faster than women in the 10-km (28:04 ± 0:17 vs. 32:08 ± 0.31 (minutes:seconds), $p < 0.001$, $d = -9.48$); half-marathon (1:01:58 ± 0:00:52 vs. 1:11:21 ± 0:01:18 (hours:minutes:seconds), $p < 0.001$, $d = -8.41$); marathon (2:13:42 ± 0:03:01 vs. 2:35:04 ± 0:05:21 (hours:minutes:seconds), $p < 0.001$, $d = -4.90$); and 100-km ultramarathon (6:48:01 ± 0:11:29 vs. 7:53:51 ± 0:16:37 (hours:minutes:seconds), $p < 0.001$, $d = -4.61$) (Figure 2).

Age and Running Speed in the 10-km Event

Women were older than men in the 10-km race (32.0 ± 6.0 vs. 25.3 ± 4.3 years, $p < 0.001$, $d = 1.28$); half-marathon (27.5 ± 4.7 vs. 25.9 ± 4.1 years, $p < 0.001$, $d = 0.36$); and marathon (29.5 ± 5.5 vs. 29.1 ± 4.3 years, $p < 0.001$, $d = 0.08$), but did not differ in the 100-km ultramarathon race (36.6 ± 6.1 vs. 35.9 ± 5.5 years, $p = 0.097$ $d = 0.12$). In the 10-km event, the race time differed by nationality among both women ($p < 0.001$, $\eta^2 = 0.116$) (Table 3) and men ($p < 0.001$, $\eta^2 = 0.025$) (Table 4). Among women, athletes from The Netherlands were faster than all others, except athletes from Morocco, New Zealand, and Romania, whereas athletes from Japan were slower than all the others except those from Ethiopia, Great Britain, Kenya, Morocco, and The Netherlands. Among men, the runners from Kenya were faster than runners from Morocco. The ages also differed by nationality among both women ($p < 0.001$, $\eta^2 = 0.271$) and men ($p < 0.001$, $\eta^2 = 0.076$). Among women, the runners from Ethiopia were younger than all others except the athletes from Brunei and New Zealand, whereas runners from Romania were older than all others except the runners from France, Germany, and The Netherlands. Among men, the runners from Uganda were younger than runners from Kenya, Morocco, and the United States, whereas runners from the United States were older than all the others except the runners from Morocco.

Age and Running Speed in the Half-Marathon

In the half-marathon, the age varied by nationality among women ($p < 0.001$, $\eta^2 = 0.31$) (Table 5) and men ($p < 0.001$, $\eta^2 = 0.14$) (Table 6). Among women, athletes from Eritrea were the youngest except for those from Brunei, China, Ethiopia, Japan, South Korea, and Lithuania, whereas Slovenians were the oldest. Among men, Ethiopians were younger than the athletes from Australia, Brazil, Spain, France, Great Britain, Italy, Kenya, Morocco, Mexico, The Netherlands, Portugal, Republic of South Africa, Tanzania, and the United States, whereas the Portuguese were older than the athletes from Algeria,

Table 7. Nationality, number of participants, age, and marathon race time in women, sorted in alphabetical order of the name of the country.*

Nationality	*n*	Age (y)	Time (h:min:s)
Algeria	15	31 ± 3.53	2:33:16.27 ± 0:05:53.16
Argentina	19	33.11 ± 2.77	2:40:07.47 ± 0:02:35.88
Australia	90	32.19 ± 4.31	2:35:04.08 ± 0:05:01.79
Austria	28	34.43 ± 2.96	2:37:21.07 ± 0:03:41.58
Burundi	9	29.11 ± 1.76	2:33:04.56 ± 0:04:54.96
Belgium	30	32.04 ± 3.96	2:36:00.97 ± 0:05:41.17
Bosnia and Herzegovina	10	30 ± 2.36	2:37:28.90 ± 0:01:35.00
Belarus	117	30.61 ± 4.70	2:36:37.06 ± 0:04:23.63
Bolivia	1	24	2:39:17.00
Botswana	1	23	2:41:31.99
Brazil	73	32.49 ± 3.62	2:38:36.48 ± 0:03:22.91
Brunei	25	26.96 ± 2.49	2:34:23.52 ± 0:05:06.69
Bulgaria	3	32.33 ± 9.81	2:41:01.33 ± 0:03:01.80
Canada	66	33.92 ± 5.02	2:36:43.24 ± 0:04:20.03
Chile	17	35.21 ± 2.58	2:39:02.00 ± 0:02:49.60
China	636	22.72 ± 3.35	2:35:10.64 ± 0:05:21.38
Chinese Taipei	3	34.33 ± 5.86	2:42:28.33 ± 0:02:20.63
Colombia	11	30.82 ± 4.09	2:37:01.45 ± 0:03:00.17
Costa Rica	2	32 ± 1.41	2:40:05.50 ± 0:02:26.37
Croatia	13	30.77 ± 4.94	2:35:32.23 ± 0:06:54.04
Cuba	11	29.27 ± 4.65	2:39:51.64 ± 0:01:46.21
Czech Republic	17	33.53 ± 4.21	2:37:19.71 ± 0:02:58.12
Denmark	33	34.91 ± 4.45	2:36:24.12 ± 0:03:34.22
Ecuador	17	32.59 ± 3.41	2:38:46.82 ± 0:03:59.10
Eritrea	7	29.43 ± 5.19	2:37:02.14 ± 0:04:02.26
Estonia	16	30.88 ± 3.01	2:37:49.31 ± 0:04:26.24
Ethiopia	1,762	25.69 ± 3.82	2:33:29.02 ± 0:05:36.42
Finland	17	34.12 ± 2.74	2:39:41.59 ± 0:02:21.49
France	108	34.56 ± 4.23	2:36:39.43 ± 0:04:36.78
Great Britain	224	33.00 ± 4.31	2:36:18.97 ± 0:05:37.25
Germany	172	31.38 ± 5.14	2:33:48.35 ± 0:05:27.27
Greece	17	31.76 ± 4.68	2:40:23.82 ± 0:01:31.76
Hong Kong	2	27 ± 0	2:40:56.00 ± 0:03:34.96
Hungary	40	32.92 ± 4.94	2:36:51.50 ± 0:04:11.29
Indonesia	2	24 ± 1.41	2:36:32.00 ± 0:06:40.22
India	5	29.6 ± 2.51	2:37:40.00 ± 0:02:55.17
Ireland	39	33.51 ± 3.59	2:37:31.33 ± 0:03:28.98
Islamic Republic of Iran	6	36.17 ± 1.83	2:38:51.67 ± 0:01:36.93
Italy	253	33.04 ± 4.93	2:34:32.32 ± 0:04:32.59
Japan	1,048	28.56 ± 4.57	2:34:03.03 ± 0:05:26.27
Kazakhstan	4	29 ± 6.38	2:40:42.25 ± 0:01:51.08
Kenya	1,526	29.70 ± 4.03	2:34:27.38 ± 0:05:47.48
Kyrgyzstan	26	34.76 ± 7.11	2:34:49.58 ± 0:04:13.67
Latvia	24	31.5 ± 4.76	2:29:25.92 ± 0:05:54.87
Lesotho	3	27.67 ± 3.21	2:38:56.67 ± 0:00:37.16
Lithuania	60	28.92 ± 3.55	2:34:29.33 ± 0:03:48.29
Madagascar	1	32	2:38:21.00
Morocco	14	31.36 ± 3.63	2:36:53.43 ± 0:05:20.37
Moldova	21	34.10 ± 2.70	2:37:28.67 ± 0:02:55.25
Mexico	146	31.41 ± 4.10	2:36:36.45 ± 0:04:41.63
Mongolia	10	27.3 ± 4.0	2:39:52.40 ± 0:02:31.84
Montenegro	4	28.75 ± 1.71	2:40:59.00 ± 0:01:23.41
Myanmar	1	25	2:38:42.00
Namibia	40	31.22 ± 2.51	2:33:45.40 ± 0:04:26.29
The Netherlands	85	34.68 ± 4.82	2:35:22.06 ± 0:05:27.43
Norway	36	32.94 ± 4.43	2:36:49.11 ± 0:04:28.90

North Korea	284	23.90 ± 3.16	2:35:42.89 ± 0:04:15.11
New Zealand	50	34.06 ± 4.85	2:36:31.70 ± 0:05:06.15
Paraguay	3	32 ± 1	2:37:04.33 ± 0:01:02.04
Peru	45	30.76 ± 3.22	2:36:27.36 ± 0:04:25.92
Philippines	1	26	2:38:44.00
Palestine	1	23	2:41:44.00
Poland	191	31.94 ± 4.41	2:36:05.20 ± 0:04:24.90
Portugal	77	31.8 ± 2.91	2:32:33.22 ± 0:05:13.33
Puerto Rico	1	28	2:41:56.00
Romania	135	33.65 ± 3.74	2:32:44.26 ± 0:05:23.94
Republic of South Africa	50	31.5 ± 3.22	2:37:04.92 ± 0:04:42.87
Russia	888	32.54 ± 5.59	2:34:45.61 ± 0:05:13.84
Rwanda	4	30.5 ± 3.70	2:39:20.75 ± 0:03:37.39
Serbia and Montenegro	8	27.63 ± 1.60	2:30:52.87 ± 0:03:22.20
Slovenia	21	34.76 ± 4.73	2:35:18.43 ± 0:05:28.51
Serbia	15	32.6 ± 3.38	2:37:49.73 ± 0:03:11.44
South Korea	220	25.81 ± 4.54	2:37:23.73 ± 0:03:55.37
Spain	119	33.57 ± 3.49	2:35:56.59 ± 0:04:01.40
Sri Lanka	1		2:40:07.00
Switzerland	40	32.43 ± 4.97	2:36:50.48 ± 0:04:17.20
Slovakia	6	27.2 ± 2.77	2:39:28.33 ± 0:02:28.20
Sweden	66	32.55 ± 4.85	2:36:31.18 ± 0:05:09.80
Tanzania	15	23.87 ± 3.07	2:35:48.60 ± 0:05:04.68
Thailand	1	30	2:40:39.99
Tajikistan	1	27	2:39:03.00
Tunisia	2	26.5 ± 0.71	2:41:14.00 ± 0:01:26.26
Turkey	54	30.72 ± 3.80	2:36:21.74 ± 0:04:32.83
Uganda	12	28.72 ± 3.20	2:38:52.25 ± 0:03:24.88
Ukraine	215	32.62 ± 5.80	2:35:21.28 ± 0:04:42.09
Soviet Union	1	48	2:39:38.00
United States	634	31.23 ± 5.05	2:37:48.47 ± 0:04:27.33
Uzbekistan	2	25.5 ± 0.71	2:40:12.50 ± 0:02:16.47
Venezuela	4	28.5 ± 1.29	2:42:30.25 ± 0:01:39.89
Zimbabwe	27	34.52 ± 4.06	2:37:01.81 ± 0:04:05.51
Total	10,208	29.52 ± 5.46	2:35:03.83 ± 0:05:21.41

*Total number of participants included also 48 cases which did not report nationality.

Brunei, Eritrea, Ethiopia, Italy, Japan, Kenya, Qatar, Republic of South Africa, Rwanda, Tanzania, Uganda, Ukraine, the United States, and Zimbabwe. Also, the race time varied by nationality among women ($p < 0.001$, $\eta^2 = 0.06$) and men ($p < 0.001$, $\eta^2 = 0.08$). Among women, New Zealanders were faster than athletes from China, Spain, Japan, Poland, and the United States, whereas Polish athletes were slower than the Ethiopians, Kenyans, and New Zealanders. Among men, the Eritreans were faster than athletes from Brazil, Spain, France, Italy, Japan, Kenya, Morocco, The Netherlands, Portugal, Republic of South Africa, Uganda, Ukraine, the United States, and Zimbabwe, whereas the Portuguese were slower than athletes from Eritrea, Ethiopia, and Kenya.

Age and Running Speed in the Marathon

In the marathon, the race time varied by nationality among women ($p < 0.001$, $\eta^2 = 0.07$) (Table 7) and men ($p < 0.001$, $\eta^2 = 0.07$) (Table 8). Among women, the Brazilians were slower than athletes from Australia, China, Ethiopia, Germany, Italy, Japan, Kenya, Latvia, Lithuania, Namibia, Portugal, North Korea, Romania, Russia, and Ukraine, and the Latvians were the fastest, except for the athletes from Brunei, Ethiopia, Germany, Kyrgyz Republic, Lithuania, Namibia, Romania, Slovenia, and Tanzania. Among men, the Ethiopians were faster than athletes from Australia, Belgium, Belarus, Brazil, Canada, China, Colombia, Great Britain, Germany, Ireland, Islamic Republic of Iran, Kenya, South Korea, Lesotho, Morocco, Mexico, The Netherlands, New Zealand, Peru, Poland, North Korea, Republic of South Africa, Russia, Tanzania, Ukraine, the United States, and Zimbabwe, whereas the Irish were slower than the athletes from Eritrea, Spain, Ethiopia, Italy, Kenya, Qatar, Switzerland, and Uganda. Also, the ages varied by nationality among both women ($p < 0.001$, $\eta^2 = 0.36$) and men ($p < 0.001$, $\eta^2 = 0.17$). Among women, the Chinese were the youngest, except for athletes from North Korea and Tanzania, whereas the Danish were older than athletes from

Table 8. Nationality, number of participants, age, and marathon race time in men, sorted in alphabetical order of the name of the country.*

Nationality	*n*	Age (y)	Time (h:min:s)
Algeria	18	30.59 ± 3.69	2:14:46.83 ± 0:02:13.35
Andorra	8	39.63 ± 2.62	2:16:15.13 ± 0:01:25.54
Angola	2	37 ± 2.83	2:15:54.00 ± 0:01:02.22
Argentina	10	30.7 ± 2.36	2:16:10.50 ± 0:01:21.35
Australia	79	31.22 ± 3.26	2:14:15.41 ± 0:02:09.25
Austria	19	32.89 ± 1.79	2:15:05.00 ± 0:02:01.72
Azerbaijan	2	23.5 ± 0.71	2:13:11.00 ± 0:02:34.14
Burundi	11	29.55 ± 3.86	2:15:24.18 ± 0:01:38.79
Belgium	62	33.69 ± 5.25	2:15:21.32 ± 0:02:04.77
Bosnia and Herzegovina	1	37	2:16:45.00
Belarus	34	30.24 ± 3.54	2:14:57.21 ± 0:01:57.10
Botswana	5	26.5 ± 3.54	2:16:42.60 ± 0:01:33.36
Brazil	134	31.12 ± 3.86	2:14:27.31 ± 0:02:51.94
Brunei	33	27.06 ± 4.34	2:13:31.91 ± 0:03:11.59
Bulgaria	1	32	2:16:58.00
Canada	47	31.31 ± 3.16	2:14:41.81 ± 0:02:27.73
Chile	8	33.14 ± 3.13	2:17:08.75 ± 0:00:52.67
China	171	24.18 ± 3.16	2:15:46.78 ± 0:01:48.39
Chinese Taipei	7	28.29 ± 3.40	2:16:51.86 ± 0:00:41.52
Colombia	22	32.36 ± 4.44	2:15:43.05 ± 0:01:28.14
Costa Rica	2	30 ± 1.41	2:17:51.00 ± 0:00:01.41
Cuba	8	28 ± 5.24	2:15:48.63 ± 0:01:28.13
Czech Republic	7	30.43 ± 4.04	2:17:32.71 ± 0:00:32.81
Democratic Republic of the Congo	19	28.42 ± 4.15	2:14:06.63 ± 0:03:12.89
Denmark	12	30.33 ± 3.28	2:16:57.00 ± 0:00:51.62
Ecuador	13	33.58 ± 3.75	2:15:18.31 ± 0:01:33.51
Eritrea	141	28.99 ± 4.26	2:13:24.03 ± 0:03:10.06
Estonia	11	34.27 ± 2.15	2:12:31.18 ± 0:03:09.56
Ethiopia	1,928	26.74 ± 3.78	2:12:48.99 ± 0:03:13.94
Finland	16	30.56 ± 3.92	2:14:26.69 ± 0:02:15.24
France	131	31.82 ± 3.71	2:13:39.28 ± 0:02:48.57
Great Britain	102	30.88 ± 3.26	2:15:18.93 ± 0:02:10.00
Georgia	1	23	2:16:17.00
Germany	54	29.78 ± 3.29	2:15:12.37 ± 0:02:05.98
Greece	8	31.88 ± 1.89	2:15:31.62 ± 0:02:11.78
Guatemala	12	30 ± 4.41	2:15:22.42 ± 0:01:31.76
Hungary	6	27.17 ± 2.99	2:16:51.00 ± 0:01:31.85
India	4	30.5 ± 2.12	2:17:37.50 ± 0:00:29.24
Ireland	27	30.33 ± 3.03	2:16:33.93 ± 0:01:42.91
Islamic Republic of Iran	22	39.59 ± 7.38	2:16:19.27 ± 0:01:04.48
Iceland	1	25	2:17:0:12.00
Israel	3	30.67 ± 6.35	2:17:21.33 ± 0:01:37.74
Italy	225	32.55 ± 3.93	2:13:37.95 ± 0:02:40.66
Jordan	1		2:17:24.00
Japan	1,271	28.78 ± 3.27	2:14:16.14 ± 0:02:38.02
Kazakhstan	2	24.5 ± 3.54	2:16:03.00 ± 0:00:07.07
Kenya	6,172	28.90 ± 4.20	2:13:15.80 ± 0:03:06.27
Kyrgyz Republic	1	25	2:17:58.99
South Korea	202	27.04 ± 4.71	2:15:08.99 ± 0:02:34.50
Latvia	8	28.25 ± 1.589	2:16:13.75 ± 0:01:13.76
Libya	4	29.5 ± 2.89	2:15:43.25 ± 0:01:55.54
Saint Lucia	2	29 ± 1.41	2:16:25.00 ± 0:00:26.87
Lesotho	23	27.75 ± 5.20	2:15:48.83 ± 0:01:10.48
Lithuania	3	26.33 ± 2.89	2:15:02.00 ± 0:01:56.01
Morocco	62	32.59 ± 4.51	2:14:34.40 ± 0:03:10.14
Moldova	20	31.75 ± 2.63	2:14:08.15 ± 0:02:22.84

Mexico	133	32.01 ± 3.94	2:15:13.95 ± 0:02:03.07
Mongolia	26	30.73 ± 2.47	2:14:14.12 ± 0:02:45.12
Namibia	9	32.88 ± 5.08	2:14:37.00 ± 0:02:02.64
The Netherlands	73	31.34 ± 3.90	2:14:15.58 ± 0:02:33.24
New Zealand	23	31.83 ± 1.59	2:16:05.83 ± 0:01:38.30
Norway	18	31.28 ± 3.66	2:15:48.56 ± 0:01:39.46
North Korea	59	26.08 ± 2.01	2:15:17.99 ± 0:01:50.87
New Zealand	23	31.83 ± 1.59	2:16:05.83 ± 0:01:38.30
Pakistan	1	29	2:14:11.00
Peru	22	32.64 ± 3.67	2:15:51.91 ± 0:01:50.90
Poland	174	30.52 ± 3.78	2:14:40.91 ± 0:02:18.49
Portugal	72	33.75 ± 3.08	2:13:53.17 ± 0:02:28.72
Puerto Rico	1	36	2:17:58.99
Qatar	80	26.83 ± 3.37	2:13:11.54 ± 0:02:49.77
Romania	5	28.4 ± 1.67	2:15:00.60 ± 0:01:28.85
Republic of South Africa	195	30.71 ± 4.18	2:14:20.72 ± 0:03:03.93
Russia	257	30.24 ± 3.95	2:14:33.30 ± 0:02:18.81
Rwanda	9	32.44 ± 4.67	2:14:53.22 ± 0:02:41.63
Saint Vincent and the Grenadines	1	30	2:15:30.00
Slovenia	12	33.92 ± 4.44	2:16:23.17 ± 0:02:01.40
Serbia	1	25	2:17:10.00
Spain	157	33.03 ± 3.21	2:13:12.47 ± 0:02:54.58
Sri Lanka	5	33.6 ± 4.39	2:16:23.80 ± 0:01:41.55
Sudan	1	27	2:14:32.00
Switzerland	31	32.74 ± 3.92	2:13:23.58 ± 0:03:01.98
Slovakia	3	33 ± 2.65	2:14:38.33 ± 0:02:28.38
Sweden	14	30.86 ± 2.93	2:15:47.14 ± 0:02:07.97
Tanzania	120	26.27 ± 3.50	2:14:08.37 ± 0:02:28.06
Trinidad and Tobago	1	32	2:17:29.00
Tunisia	4	27 ± 1.41	2:16:51.75 ± 0:00:54.90
Turkey	8	27.88 ± 3.52	2:16:17.75 ± 0:01:21.88
Uganda	61	25.82 ± 3.45	2:13:29.20 ± 0:03:02.62
Ukraine	201	30.55 ± 3.93	2:14:21.40 ± 0:02:25.83
Uruguay	3	28.33 ± 1.15	2:15:07.67 ± 0:01:47.90
United States	380	29.25 ± 3.73	2:14:59.85 ± 0:02:35.33
Venezuela	9	29 ± 4.38	2:14:56.33 ± 0:02:27.06
Zambia	3	26 ± 1	2:12:21.67 ± 0:00:46.50
Zimbabwe	80	30.85 ± 3.41	2:15:37.21 ± 0:01:38.05
Total	13,765	29.09 ± 4.32	2:13:42.12 ± 0:03:01.30

*Total number of participants included also 315 cases which did not report nationality.

Belarus, Brunei, China, Ethiopia, Germany, Japan, Kenya, South Korea, Lithuania, Peru, North Korea, Tanzania, Turkey, and the United States. Among men, athletes from the Islamic Republic of Iran were the oldest, and the Chinese were the youngest, except for the athletes from Brunei, Lesotho, North Korea, and Uganda.

Age and Running Speed in the 100-km Ultramarathon

In the 100-km event, ages differed by nationality among both women ($p < 0.001$, $\eta^2 = 0.18$) (Table 9) and men ($p < 0.001$, $\eta^2 = 0.22$) (Table 10). Among women, runners from the United States were older than runners from Croatia, France, Japan, and Russia, whereas runners from Russia were the youngest, except for the athletes from Croatia and Sweden. Among men, the Ukrainians were younger than the runners from Spain, Germany, and Italy, and the Germans were older than the runners from Japan, Russia, Ukraine, and the United States. The race times differed by nationality among women ($p < 0.001$, $\eta^2 = 0.10$) and men ($p = 0.028$, $\eta^2 = 0.06$) as well. Among women, the athletes from Russia were faster than the athletes from France and Germany. Among men, the post hoc analysis did not reveal any difference among the various nationalities.

Age and Race Time by Calendar Year and Race Distance

Race times in all race distances differed among calendar years ($p \leq 0.043$) (Table 11). A sex × calendar year interaction was observed in the marathon and the 100-km ultramarathon ($p < 0.001$), but not in the 10-km and half-marathon races ($p > 0.05$). No difference was observed in the ages of participants among calendar years ($p > 0.05$) (Table 12). The variation in age and race time

Table 9. Nationality, number of participants, age, and 100-km race time in women, sorted in alphabetical order of the name of the country.

Nationality	*n*	Age (y)	Time (h:min:s)
Australia	4	42 ± 0	7:49:32.25 ± 0:13:14.53
Austria	2	49 ± 1.41	8:00:25.00 ± 0:02:38.39
Belgium	1		7:57:05.00
Brazil	1		7:57:43.00
Canada	1	32	8:26:57.00
Croatia	13	34.77 ± 4.55	7:46:35.23 ± 0:09:30.67
Czech Republic	1	38	7:56:55.00
France	38	36.5 ± 4.76	7:59:39.76 ± 0:11:51.02
Great Britain	17	38.47 ± 5.12	7:47:36.59 ± 0:12:21.29
Germany	35	37.91 ± 6	8:01:53.83 ± 0:13:33.61
Hungary	7	38.29 ± 4.03	7:49:15.86 ± 0:11:56.20
Ireland	3	41 ± 1	7:57:02.00 ± 0:06:37.62
Italy	29	37.31 ± 5.51	7:56:03.28 ± 0:17:22.49
Japan	70	35.99 ± 4.55	7:52:01.76 ± 0:19:45.50
Norway	2	44.5 ± 2.12	8:03:40.00 ± 0:28:35.44
Poland	3	40 ± 7	7:44:34.33 ± 0:14:49.73
Portugal	1	43	7:57:34.00
Republic of South Africa	3	39.5 ± 4.95	8:05:40.00 ± 0:23:11.14
Russia	55	32.15 ± 6.16	7:47:51.60 ± 0:17:25.00
South Korea	2	29.5 ± 0.71	8:12:27.00 ± 0:10:25.08
Switzerland	4	32.75 ± 6.95	7:59:34.25 ± 0:08:31.48
Slovakia	1	38	7:33:01.99
Sweden	10	34.5 ± 4.9	7:44:49.50 ± 0:12:11.26
United States	40	40.89 ± 7.18	7:56:14.80 ± 0:16:14.20
Total	343	36.6 ± 6.07	7:53:51.27 ± 0:16:36.821

by calendar year, sex, and race distance is shown in Figures 3 and 4, respectively.

Relationship Between Age and Race Time by Race Distance

The correlation analysis between age and race time showed variation by race distance (Table 13). Particularly, there was a significant correlation in all race distances ($p \leq 0.05$), except for the half-marathon event among women and the 10-km event among men. Moreover, the magnitude of correlation varied as well. A trivial magnitude was observed in the 10-km (women), half-marathon (women), and marathon (women), whereas a small magnitude was shown in the half-marathon (men), marathon (men), and 100-km (women and men). Thus, the magnitude of the correlation between age and race time was higher in men than in women. Except in the 10-km (women), the direction of this relationship was positive, i.e., the older the age, the higher (slower) the race time.

Discussion

In this study, we have examined the variations in the running performance in races ranging from 10-km to 100-km ultramarathon by sex and nationality. The main findings were that (a) most runners were from Kenya and Ethiopia in the 10-km, half-marathon, and marathon, but were from Japan and Russia in the 100-km ultramarathon, (b) women were older than men in all distance events, except in the 100-km ultramarathon, and that men were the fastest in all distances, and (c) East Africans were not the fastest compared with athletes originating from other countries, where only Ethiopian men were faster than all other men in the marathon.

A first important finding was that East African runners from Ethiopia and Kenya were among the most numerous in the 10-km, half-marathon, and marathon events, but not in the 100-km ultramarathon race. Interestingly, East Africans were not the fastest compared with athletes originating from other countries. Only the Ethiopian men were faster than all other men in the marathon. The most likely explanation is that the large number of Kenyan and Ethiopian runners–compared with runners from other countries–were qualified to be listed in this database. Furthermore, other top athletes from other countries seem to achieve a similar performance against the best Kenyan and Ethiopian runners.

A further interesting and unexpected finding was that Japanese runners were among the most numerous in the 10-km, half-marathon, marathon, and 100-km ultramarathon events. The dominance of Japanese runners has already been

Table 10. Nationality, number of participants, age, and 100-km race time in men, sorted in alphabetical order of the name of the country.

Nationality	*n*	Age (y)	Time (h:min:s)
Argentina	1	42	6:59:07.00
Australia	2	35 ± 0	7:01:43.00 ± 0:00:09.89
Belgium	5	34 ± 2.45	6:51:03.40 ± 0:06:44.78
Belarus	2	33.5 ± 0.71	6:43:16.50 ± 0:13:12.66
Brazil	1	43	6:47:29.00
Czech Republic	3	39.67 ± 1.53	6:57:45.67 ± 0:02:46.03
Denmark	1	29	6:57:35.00
Finland	1	32	6:56:48.99
France	45	39.21 ± 4.91	6:50:45.42 ± 0:10:42.12
Great Britain	11	36.9 ± 4.23	6:48:06.09 ± 0:15:07.74
Germany	15	39.79 ± 3.83	6:52:03.27 ± 0:11:06.006
Hungary	6	36.5 ± 1.64	6:49:12.67 ± 0:10:11.809
Ireland	3	34 ± 2	7:07:11.33 ± 0:02:56.222
Italy	42	37.95 ± 3.19	6:46:56.79 ± 0:13:18.963
Japan	77	32.62 ± 4.95	6:45:49.69 ± 0:11:06.695
Kenya	3	38.33 ± 1.53	6:44:33.67 ± 0:09:11.391
Lithuania	1	34	6:50:34.00
The Netherlands	3	47.5 ± 9.19	6:54:28.00 ± 0:05:20.61
Norway	3	35.67 ± 1.53	7:02:28.67 ± 0:01:21.73
New Zealand	2	35.5 ± 0.71	6:52:30.50 ± 0:08:01.54
Poland	14	36.93 ± 4.6	6:44:41.57 ± 0:09:27.13
Republic of South Africa	1	33	6:46:09.99
Russia	72	34.42 ± 6.51	6:44:42.54 ± 0:11:47.62
Slovenia	1	39	6:47:52.99
Spain	24	38.67 ± 4.28	6:46:46.21 ± 0:11:41.74
Switzerland	3	38 ± 4.36	6:57:45.00 ± 0:07:22.91
Sweden	8	38.86 ± 2.27	6:41:17.62 ± 0:12:22.53
Ukraine	10	31.67 ± 5.15	6:50:46.20 ± 0:07:56.67
United States	30	34.07 ± 4.93	6:52:09.53 ± 0:08:40.57
Total	390	35.87 ± 5.47	6:48:01.28 ± 0:11:28.58

reported for 100-km ultramarathoners (5), but not for shorter running distances. When race times and nationalities from 112,283 athletes (i.e., 15,204 women and 97,079 men) competing between 1998 and 2011 in a 100-km ultramarathon, and originating from 102 countries worldwide were investigated, most of the finishers (73.5%) were from Europe, in particular from France (30.4%), but Japanese women and men were the fastest (5). Unfortunately, very little is known about Japanese ultramarathoners and their life style (27), but no data are available for Japanese athletes competing in shorter distances. Future studies need to investigate why Japanese runners are among the fastest in the 10-km, half-marathon, marathon, and 100-km ultramarathon events.

Although female and male runners from Ethiopia and Kenya were the most numerous in the 10-km, half-marathon, and marathon, only the Ethiopian men were faster than all the other men in the marathon race. Although both elite Ethiopian (25) and elite Kenyan (22) runners have a similar environmental background in terms of geographical distribution, male Ethiopian marathoners were faster than male Kenyan marathoners. A possible explanation could be that Ethiopian runners have the better running economy and higher aerobic capacity compared with other runners (19,28). The density in performance in Ethiopian runners could also be an explanation, since only 1,928 Ethiopian men were faster than the cut-off of 2:19:00 (hours:minutes:seconds), whereas by contrast, 6,172 Kenyan men were faster than 2:19:00 (hours:minutes:seconds).

A further important finding was that women were older than men for the 10-km, half-marathon, and marathon, but not in the 100-km ultramarathon. This finding confirms the results from Hunter et al. (10) where the 5 fastest women competing in the 7 marathons of the World Marathon Majors Series were faster than the fastest 5 men. However, the sex difference was only obvious in 2 races (i.e., Chicago and London) but not for the other considered races (i.e., Berlin, Boston, New York City, World Championship, and the Olympic marathons).

The finding that women achieved their best running performances at higher ages compared with men for the

Table 11. Coefficients (C) and standard errors (*SE*) from multivariate regression models for the race time by calendar year in women and men.

	C	*SE*	*p*
10 km			
Sex (=female)	−14,160.13	34,959.40	0.685
Calendar year	25.36	12.50	0.043
Sex × calendar year × nationality	14.33	17.39	0.410
21.1 km			
Sex (=female)	−119.12	582.75	0.838
Calendar year	−1.38	0.19	<0.001
Sex × calendar year nationality	0.34	0.29	0.241
42.2 km			
Sex (=female)	−15,629.41	1,568.90	<0.001
Calendar year	1.74	0.51	0.001
Sex × calendar year	8.42	0.78	<0.001
100 km			
Sex (=female)	146,247.26	26,315.87	<0.001
Calendar year	63.03	8.82	<0.001
Sex × calendar year	−70.86	13.11	<0.001

10-km up to the marathon is difficult to explain. Likely explanations could be that women started their athletic careers in running later in life due to professional and familial (i.e., pregnancy, child birth) reasons. The finding that women and men achieve their fastest ultramarathon performance at the same age confirms recent findings for 100 km (5) and 100 miles (24) ultramarathoners. Also for Ironman triathletes, women and men achieve their best performance at the same age (23,26). The importance of the role of age in race timings was highlighted also by the correlations of these 2 variables. The data analysis in the present study indicated that age might have a different impact on race times (i.e., the older the age, the slower the athlete) according to race distance, and this impact seems to be relatively stronger in the longer race distances. This finding was in agreement with a previous study on marathons, in which an increase of race time with increasing age after the age of 35 years was observed

Table 12. Coefficients (C) and standard errors (*SE*) from multivariate regression models for the age of participants by calendar year in women and men.

	C	*SE*	*p*
10 km			
Sex (=female)	2,050.00	103.71	<0.001
Calendar year	−0.04	0.04	0.272
Sex × calendar year	−1.02	0.05	<0.001
21.1 km			
Sex (=female)	−10.39	39.39	0.795
Calendar year	0.01	0.01	0.440
Sex × calendar year	0.01	0.02	0.764
42.2 km			
Sex (=female)	81.43	31.50	0.010
Calendar year	−0.001	0.01	0.892
Sex × calendar year	−0.04	0.02	0.010
100 km			
Sex (=female)	−205.55	190.54	0.281
Calendar year	0.08	0.06	0.213
Sex × calendar year	0.10	0.09	0.279

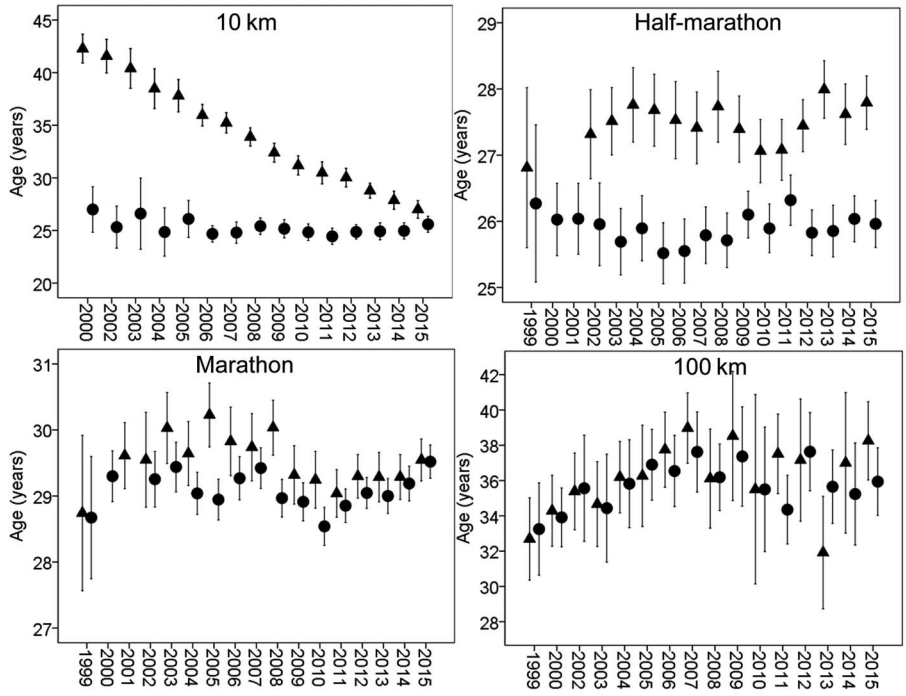

Figure 3. Running speed by calendar year and sex. Women are depicted in ▲ and men in ●.

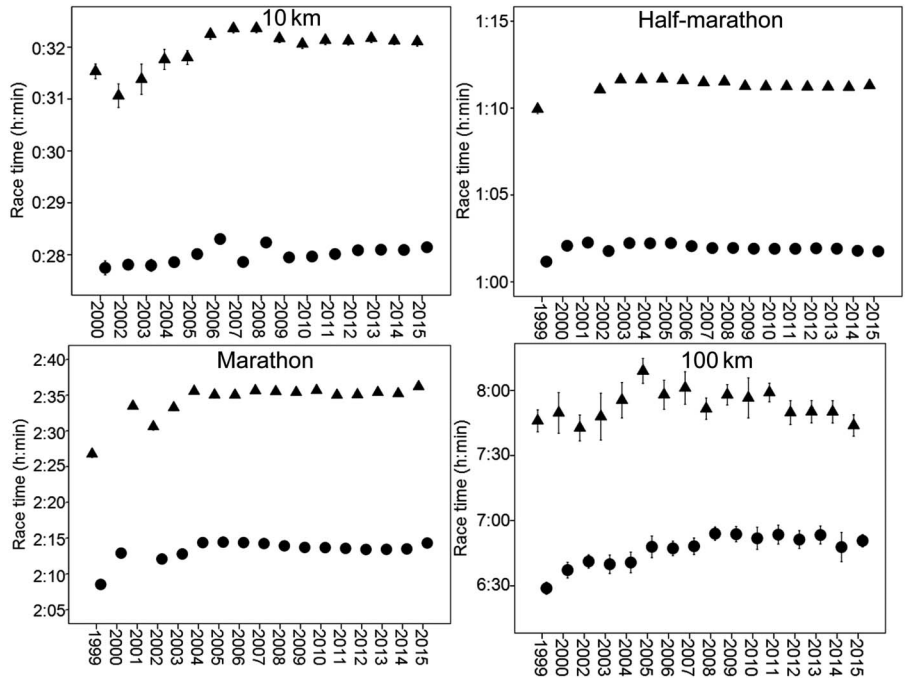

Figure 4. Age by calendar year and sex. Women are depicted in ▲ and men in ●.

Table 13. Relationship between age and race time by race distance.

	Women		Men	
Race distance (km)	*r*	*p*	*r*	*p*
10	−0.063	0.021	0.037	0.192
21.1	0.013	0.346	0.102	<0.001
42.2	0.081	<0.001	0.111	<0.001
100	0.172	0.002	0.131	0.012

(12). Another study also showed an increase in race times with increasing age after the age of 30 years (16).

The strength of this study is that all athletes from all countries were considered and, therefore, a selection bias (i.e., limitation to the fastest of a country) was eliminated. A weakness and limitation of the study is that the specific aspects of anthropometry, physiology, and running economy could not be considered since East African runners differ in these aspects from athletes from other countries. The finding that runners from Japan were among the best runners in the 10-km, half-marathon, marathon, and 100-km ultramarathon races needs further consideration in future studies. And the finding that Ethiopian men marathoners were faster than Kenyan marathoners should lead to a comparison of anthropometric and physiological characteristics as well as the running economy between Ethiopian and Kenyan marathoners. It should be highlighted that the analysis concerned the nationality of the athletes and not their ethnicity. It is possible that an athlete might change their nationality considering the phenomenon of the so-called "borderless athletes" (6). According to this phenomenon, athletes had transcended ethnicity or national borders increasingly in magnitude in recent years (8). For instance, it was recorded in 1987 that ~5% of the track-and-field college athletes in the United States were recruited from other countries, the majority being from Kenya (3). Therefore, the findings on the role of nationalities should be generalized with caution when considering the abovementioned limitation.

Practical Applications

Among the world's best-ranked runners in the 10-km, half-marathon, marathon, and 100-km ultramarathon by sex and nationality during 1999–2015, most runners were from Kenya and Ethiopia in the 10-km, half-marathon, and marathon, but were from Japan and Russia in the 100-km ultramarathon. Japanese runners were among the fastest also in the 10-km, half-marathon, and marathon events. Women were older than men in all the distance events except the 100-km ultramarathon, and men were the fastest in all distance events. Although female and male runners from Ethiopia and Kenya were the most numerous in the 10-km, half-marathon, and marathon, only Ethiopian men were faster than all other men in the marathon race. Future studies need to investigate why Japanese runners were among the best in the 10-km, half-marathon, marathon, and 100-km ultramarathon events, and whether differences do exist between male Ethiopian and Kenyan marathoners. This information is of great practical value for coaches working with long-distance runners. Being aware of the role played by sex, age, and nationality on race times, and the variation of this role by race distance, might help coaches design exercise programs, and make decision with regards to which is the most suitable race distance for their athletes. For instance, based on the findings of the present study, an older athlete would be advised to compete in a longer-distance race.

References

1. Allen, SV and Hopkins, WG. Age of peak competitive performance of elite athletes: A systematic review. *Sports Med* 45: 1431–1441, 2015.
2. Aschmann, A, Knechtle, B, Cribari, M, Rust, CA, Onywera, V, Rosemann, T, and Lepers, R. Performance and age of African and non-African runners in half- and full marathons held in Switzerland, 2000–2010. *Open Access J Sports Med* 4: 183–192, 2013.
3. Bale, J and Sang, J. Kenyan athletes, talent migration and the global sports system. In: J. Bale and J. Maguire, eds. *The Global Sports Arena—Athletic Talent Migration in an Inderdependent World.* London, United kingdom: Frank Cass, 2003.
4. Cejka, N, Knechtle, B, Rüst, CA, Rosemann, T, and Lepers, R. Performance and age of the fastest female and male 100-km ultramarathoners worldwide from 1960 to 2012. *J Strength Cond Res* 29: 1180–1190, 2015.
5. Cejka, N, Rüst, CA, Lepers, R, Onywera, V, Rosemann, T, and Knechtle, B. Participation and performance trends in 100-km ultramarathons worldwide. *J Sports Sci* 32: 354–366, 2014.
6. Chiba, N, Ebihara, O, and Morino, S. Globalization, naturalization and identity—The case of borderless elite athletes in Japan. *Int Rev Sociol Sport* 36: 203–221, 2001.
7. Cohen, J. *Statistical Power Analysis for the Behavioral Sciences* (2nd ed.). Hillsdale, NJ: Lawrence Erlbaum Associates, 1988.
8. Elliott, R and Maguire, J. Thinking outside the box: Exploring a conceptual synthesis for research in the area of athletic labor migration. *Sociol Sport J* 25: 482–497, 2008.
9. Hopkins, WG, Marshall, SW, Batterham, AM, and Hanin, J. Progressive statistics for studies in sports medicine and exercise science. *Med Sci Sports Exerc* 41: 3–12, 2009.

10. Hunter, SK, Stevens, AA, Magennis, K, Skelton, KW, and Fauth, M. Is there a sex difference in the age of elite marathon runners? *Med Sci Sports Exerc* 43: 656–664, 2011.

11. Knechtle, B, Aschmann, A, Onywera, V, Nikolaidis, PT, Rosemann, T, and Rüst, CA. Performance and age of African and non-African runners in world marathon majors races 2000–2014. *J Sports Sci* 35: 1012–1014, 2017.

12. Knechtle, B, Assadi, H, Lepers, R, Rosemann, T, and Rüst, CA. Relationship between age and elite marathon race time in world single age records from 5 to 93 years. *BMC Sports Sci Med Rehabil* 6: 31, 2014.

13. Knechtle, B, Nikolaidis, PT, Onywera, VO, Zingg, MA, Rosemann, T, and Rüst, CA. Male and female Ethiopian and Kenyan runners are the fastest and the youngest in both half and full marathon. *SpringerPlus* 5: 1–33, 2016.

14. Knechtle, B, Nikolaidis, PT, Zingg, MA, Rosemann, T, and Rüst, CA. Half-marathoners are younger and slower than marathoners. *Springerplus* 5: 1–16, 2016.

15. Knechtle, B, Valeri, F, Zingg, MA, Rosemann, T, and Rüst, CA. What is the age for the fastest ultra-marathon performance in time-limited races from 6 h to 10 days? *Age (Dordr)* 36: 9715, 2014.

16. Lara, B, Salinero, JJ, and Del Coso, J. The relationship between age and running time in elite marathoners is U-shaped. *Age (Dordr)* 36: 1003–1008, 2014.

17. Larsen, HB. Kenyan dominance in distance running. *Compar Biochem Physiol A Mol Integr Physiol* 136: 161–170, 2003.

18. Larsen, HB and Sheel, AW. The Kenyan runners. *Scand J Med Sci Sports* 25: 110–118, 2015.

19. Lucia, A, Esteve-Lanao, J, Oliván, J, Gómez-Gallego, F, San Juan, AF, Santiago, C, Pérez, M, Chamorro-Viña, C, and Foster, C. Physiological characteristics of the best Eritrean runners–Exceptional running economy. *Appl Physiol Nutr Metabol* 31: 530–540, 2006.

20. Marc, A, Sedeaud, A, Schipman, J, Antero, JJ, Saulière, G, Kryger, KO, and Toussaint, JF. Geographic enrollment of the top 100 in athletics running events from 1996 to 2012. *J Sports Med Phys Fitness* 57: 418–425, 2017.

21. Onywera, VO. East African runners: Their genetics, lifestyle and athletic prowess. *Med Sport Sci* 54: 102–109, 2009.

22. Onywera, VO, Scott, RA, Boit, MK, and Pitsiladis, YP. Demographic characteristics of elite Kenyan endurance runners. *J Sports Sci* 24: 415–422, 2006.

23. Rust, CA, Knechtle, B, Knechtle, P, Rosemann, T, and Lepers, R. Age of peak performance in elite male and female Ironman triathletes competing in Ironman Switzerland, a qualifier for the Ironman world championship, Ironman Hawaii, from 1995 to 2011. *Open Access J Sports Med* 3: 175–182, 2012.

24. Rüst, CA, Knechtle, B, Rosemann, T, and Lepers, R. Analysis of performance and age of the fastest 100-mile ultra-marathoners worldwide. *Clinics* 68: 605–611, 2013.

25. Scott, RA, Georgiades, E, Wilson, RH, Goodwin, WH, Wolde, B, and Pitsiladis, YP. Demographic characteristics of elite Ethiopian endurance runners. *Med Sci Sports Exerc* 35: 1727–1732, 2003.

26. Stiefel, M, Knechtle, B, Rüst, CA, Rosemann, T, and Lepers, R. The age of peak performance in Ironman triathlon: A cross-sectional and longitudinal data analysis. *Extrem Physiol Med* 2, 2013.

27. Tokudome, S, Kuriki, K, Yamada, N, Ichikawa, H, Miyata, M, Shibata, K, Hoshino, H, Tsuge, S, Tokudome, M, Goto, C, Tokudome, Y, Kobayashi, M, Goto, H, Suzuki, S, Okamoto, Y, Ikeda, M, and Sato, Y. Anthropometric, lifestyle and biomarker assessment of Japanese non-professional ultra-marathon runners. *J Epidemiol* 14: 161–167, 2004.

28. Weston, AR, Mbambo, Z, and Myburgh, KH. Running economy of African and Caucasian distance runners. *Med Sci Sports Exerc* 32: 1130–1134, 2000.

29. Wilber, RL and Pitsiladis, YP. Kenyan and Ethiopian distance runners: What makes them so good? *Int J Sports Physiol Perform* 7: 92–102, 2012.