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Original Investigation

Running time during Mostar half-marathon in men and women aged 19 to 75 years old

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Purpose: The main purpose of the study was to establish gender- and age-specific normative data for half-marathon running time among the Mostar half-marathon finishers in 2024.
Methods: For this observational study, we used the data from the recreational 285 half-marathon finishers (195 men and 90 women, 31.6% women) categorized into five years groups: 19-29, 30-39, 40-49, 50-59 and 60-69 yrs. Running time was presented in minutes (min). Main effects for gender, age and the interaction term for gender x age were calculated by univariate analysis of variance (ANOVA) with Bonferroni post hoc corrections.
Results: The average running time was somewhat under 2 hours (1h58'40''). Gender-related differences showed that men outperformed women in running time by approximately 21 minutes (ηp^2 = .11, P< .05). There were no significant age-related differences for aging categories (ηp^2 = .02, P= .203). Gender × age interactions did not show significant main effects for running time (ηp^2 = .03, P= .091).
Conclusions: This study shows that gender differences in running time are more pronounced and in favor to men, opposed to age.

Key words: Half-marathon; Performance; Standards; Gender; Age

Introduction

Recreational running has become one of the leading types of physical activity (PA) worldwide, with a beneficial role of preventing from cardiovascular, metabolic and mental diseases.[1] Thus, it is not surprising that the popularity of engaging in such activities has risen, especially in the last two decades.[2] In has been well-documented, that the number of finishers in long-distance running increases by 3 times from 2000 to 2010.[2] In this sense, an increasing trend of running performances in both men and women has been observed, especially in half-marathon races.[3] The distance accomplished in half-marathon (21,097 m) may be more feasible and not so time-challenging, opposed to marathon and ultra-marathon runs.[4,5]

Although most people run for fun and recreation, some individuals constantly train year after year to improve their personal best time, simulating semi-pro or pro athletes.[6] Indeed, evidence shows that environmental factors, like accumulated training volume, training intensity, and peak periodization may be influenced by an individual,[7,8] only a handful of studies have examined differences normative data in running time, according to gender[4,5,9] and age[4,5,10,11]. Notably, there has been lacking of studies investigating and the interaction between gender and age and creating nomograms for running time.[9] Based on previous literature, running time should be taken into consideration, when establishing specific norms.[12]

Available studies suggest that gender differences are often shown, when observing running times.[4,5,10,11] These findings indicate, that men are faster, compared to women, because of higher maximal aerobic capacity, larger stroke volume and cardiac output,[13] and lower percentage of body fat.[14] On the other hand, women tend to have a better metabolic advantage to spare lipids[15] and carbohydrates[16] during the performance, and are more resistant towards oxidative stress and pain.[17,18] When including running characteristics, women have more stable running output throughout the entire race,[19] while men tend to have the fast start, increasing blood lactate levels or decreasing muscle glycogen levels early in the race.[20] Thus, both genders have a set of protective factors, which enable them to perform at high level. However, contrary to a previous belief, predictive models have shown that women may surpass men in both sprinting[21] and long-distance running events.[22]

Along with gender, a handful of studies have tried to examine age-related differences in running times.[4,5,10,11] In general, running times decline by age, with a decreasing trend in running velocity by a rate of .23 m/s every 10 years for men and .32 m/s for women, respectively.[23] However, Leyk et al.[11] reported, that among 144,040 half-marathon participants, running times remained relatively stable between the ages 20 and 50 years, while a steeper decline starts to occur after the age of 50 years in the range of 2.6% to 4.4% per decade, which has been confirmed by previous studies.[5] Also, trivial to small age-related differences were observed in a study by Nikolaidis et al.[10], which means that aging played a lesser role in the early part of running compared to the later stages. However, it is still unknown to what extent does a running time change by age in half-marathon runs.

By examining the differences between gender and age and establishing nomograms for running outputs, the normative values would serve for different purposes. For example, individuals ranked in the lowest percentiles should be able to

modify their training and resting regimes. Also, percentile ranks could be easily remembered and tracked over time, to screen and monitor running performance and to compare the results with others from the same or different gender- and age- categories.

Therefore, the main purpose of the study was to establish gender- and age-specific normative data for half-marathon running times among the Mostar half-marathon finishers in 2024. Based on previous studies,[4,5,9-11] we hypothesized that men would outperform women and younger men and women would exhibit faster running times, compared to their older counterparts.

Materials and methods

Study participants

The data obtained for this study were collected via online system (the GB3 timing, Dragočaj, Banja Luka, Bosnia and Herzegovina), by the 'Half Marathon Mostar 2024' in Mostar, Bosnia and Herzegovina organizing committee. In total, 285 men and women aged between 19 and 70 years old participated in the race. The race started at 8:30 am and the weather was fine and dry. The air temperature at the start was 18°C, the relative humidity was 59%, and the organizer provided refreshments every 4 kilometers of the race, and at the finish line. By registering and participating, all competitors had confirmed that they participated in the races solely at their own risk, that they were familiar with the race rules, which they would abide by, and that they were aware that participating in this race represented a potential danger that included the risk of various types of physical injury and possible death. These individuals were all recreational athletes, not professional ones, with the latter being defined as someone who supports themselves financially exclusively through sponsorships and prize money. The time limit to finish the 'Half-marathon Mostar' was 3 hours. The subjects were informed of the experimental procedures and gave their informed written consent.

Running time

\Finishing times were collected from the online GB3 system for each athlete in hours, minutes (min) and seconds (sec), which were publicly available after the race. The GB3 system is an automated on-line system that collects running times from all the runners and displays the data in the ascending order from the fastest to the slowest runner. When the runner crosses the finishing line and disconnects the sensor which goes from one side to the other side of the track, it stops the time of race competition and saves the data. For the purpose of this study, we converted hours into min to get more standardized running time values. Finally, the participants were categorized by gender (men vs. women) and age in 10-year categories (19-29, 30-39, 40-49, 50-59 and 60-69 yrs).

Statistical analysis

Descriptive statistics are summarized using the mean and standard deviation (SD). Differences in gender and age were assessed using analysis of variance (ANOVA) or Fisher's exact test, followed by post hoc comparisons between the groups. Gender and age differences were calculated by using analysis of variance (ANOVA) or Fisher exact value with *post hoc* comparison test between the groups and the magnitude of the effects sizes was reported using partial eta squared (ηp^2). To calculate correlations between age and all the study variables, we used Pearson coefficient of correlation (*r*). For each variable, we determined gender - and age - specific percentile values (10^{th}, 25^{th}, 50^{th}, $75^{th}$and 90^{th}) and used the Lambda (L), Mu (M) and Sigma (S) method, in which the optimal power to obtain normality is summarized by a smooth (L) curve and trends in the mean (M) and coefficient of variation (S) are similarly smoothed. Next, all three curves (L, M and S) are summarized based on the power of age - specific Box – Cox power transformations for normalizing the data. All analyses were performed in Statistical Packages for Social Sciences (SPSS Inc., Chicago, Illinois, USA) and the significance was set at $P< .05$.

Results

Table 1 presents the basic descriptive statistics of the study participants. No significant age differences between men and women were observed ($P> .05$). Men exhibited better running times, opposed to women ($P< .05$). Also, men outrun women in the number of half-marathons performed during the lifetime, respectively ($P< .05$). The average number of half-marathons performed was 13.1, and men had more half-marathons in their running career, compared to women (14.50 vs. 10.00, $P< .001$). Gender- and age-specific reference data for running times are shown in Table 2.

Table 1. Basic descriptive statistics of the study participants

Variables	Total sample (n = 285)	Men (n = 195)	Women (n = 90)	*P*
Age (yrs)	41.40 (14.30)	40.90 (12.00)	42.60 (18.40)	.340
Running time (min)	1h58'40" (23.90)	1h51'88" (22.20)	2h13'00" (21.10)	< .001
Number of half-marathons run (n)*	6.00 (1.00-15.00)	7.00 (1.00-15.00)	4.00 (1.00-10.00)	.012

Note: "*" denotes using median and interquartile range (25^{th} - 75^{th} percentile).

Table 2. Reference data for running (min) times for the 10^{th}, 25^{th}, 50^{th}, 75^{th} and 90^{th} percentile, according to gender and age.

Sex	N	Age	P10	P25	P50 (M)	P75	P90
Men	32	19-29 yrs	80.50	102.90	114.50	135.90	150.90
	55	30-39 yrs	86.60	99.20	109.50	119.80	134.70
	70	40-49 yrs	88.20	98.80	107.90	118.20	134.30
	31	50-59 yrs	88.00	101.90	116.60	136.10	145.70
	8	60-69 yrs	23.60	96.90	116.80	134.40	152.60

	12	19-29 yrs	113.30	135.30	141.00	150.30	156.40
	35	30-39 yrs	103.70	129.30	140.80	155.50	170.10
Women	21	40-49 yrs	91.40	107.60	128.50	141.70	149.70
	16	50-59 yrs	103.60	111.70	121.80	146.90	159.60
	5	60-69 yrs	98.30	113.00	129.20	150.70	163.20

Main effects for gender, age and a gender × age interaction for running time are presented in Table 3. Analyses showed significant main effects for gender ($F_{1,285}$ = 34.05, P< .001, ηp^2 = .11), but not for age ($F_{1,285}$ = 1.65, P= .203, ηp^2 = .02) and gender × age ($F_{1,285}$ = 2.01, P= .091, ηp^2 = .03). Men exhibited faster running time (mean diff. = -21.20 sec, 95% CI = -27.10 to -13.40, P< .001), compared to women. However, age and gender × age interaction did not significantly influence running time, pointing out that the running time was similar across different age categories and between men and women in the same age categories. The percentage of change in a specific aging category resulted in the smallest differences between ages 40-49 yrs (12.0%) and 50-59 yrs (9.3%), yet the largest differences between the ages 29-39 yrs (27.5%) were observed (Figure 1). Furthermore, we calculated the top 10 results in each age group to observe the biological role of aging and found no significant main effects for age in this sample ($F_{1,285}$ = 1.26, P= .291, ηp^2 = .02).

Table 3. Main effects for gender, age and gender * age interaction for running time (min).

Source	Type III Sum of Squares	df	Mean Square	F	*P*	ηp²
Corrected Model	33578.46	9	3730.94	7.95	.001	.21
Intercept	2318848.93	1	2318848.93	4938.29	.001	.95
Sex	15990.64	1	15990.64	34.05	.001	.11
Age	3101.39	4	775.35	1.65	.203	.02
Gender *Age	3772.23	4	943.06	2.01	.091	.03

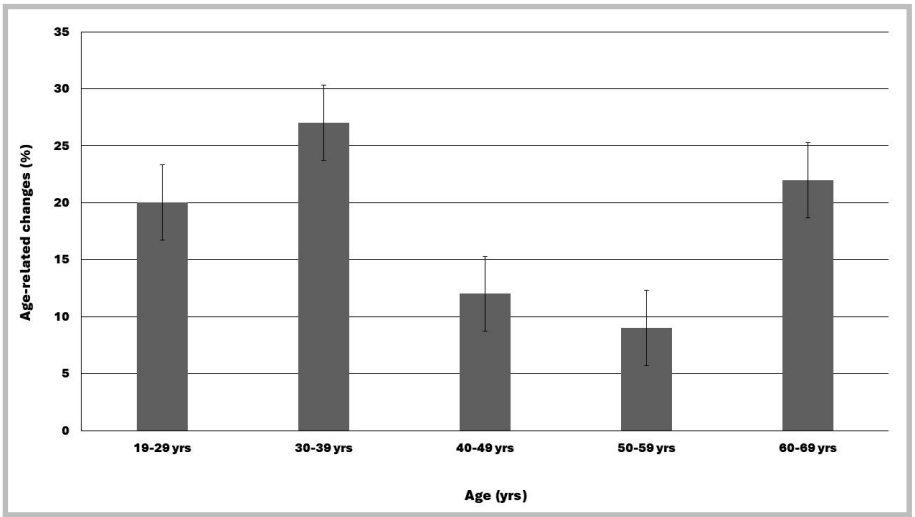

Figure 1. Age-related induced changes between men and women in running time

Discussion

The primary aim of the study was to establish gender- and age-specific normative data for half-marathon running times among the Mostar half-marathon finishers in 2024. Findings show that: i) men were faster than women, ii) men and women in the 40–49-year-old category exhibit faster times, compared to 19-29 -old men and women, and iii) no significant gender × age interaction in running times is observed.

The better running time observed in men is in line with previous findings in endurance running races.[4,5,9-11] The available evidence suggests that men are faster than women due to a numerous physiological abilities, like greater maximal oxygen uptake[24] and stroke volume, and cardiac output.[13] Biologically, men also have a greater amount of muscle mass and less percentage of fat mass, opposed to women.[14] From a psychological point of view, keeping speed at a certain rate during the race is one of the key factors for overall running performance in half-marathon.[10] Although we found that men have quicker running times, studies have shown that women maintain a more consistent output throughout the race,[19] whereas men often start quickly to have an advantage, which has detrimental effects on elevated blood lactate levels and reduced muscle glycogen levels.[20] Metabolically, women are more resilient to less favorable capacity to preserve the energy from both carbohydrates and lipids during a sustained effort and they show quicker adjustment to oxidative stress and discomfort.[17,18] Also, the proportion of men and women athletes in this study was not the same, indicating greater heterogeneity in women, opposed to men. Although our findings are somewhat expected to occur, it is still debatable: i) to what extent will men outperform women, and ii) when the differences in running time will become trivial between genders. Based on previous

regression models, women should be able to achieve similar running times as men in sprinting and long-distance running activities in the near future.[21,22]

Interestingly, we found no significant age-related differences in in running times. Although the running velocity has been shown to decline by age,[23] an arbitrary cut-off value for a marked decline has been the age of 50 yrs old.[11] When observing our sample, regardless of gender, the fastest age group was between ages 40-49 yrs, which corresponds to previous studies.[5,23] However, a study by Nikolaidis et al.[10] showed that age did not play a significant role on the running performance and we only observed one significant difference between 19-29 yrs and 40-49 yrs men and women. This would imply that running performance was not mainly influenced by age, but by other environmental factors, like a higher volume of training, and continuance of performing PA, which might have beneficial effects on physical performance and health-related quality of life.[25,26] Thus, regular exercise preserves musculoskeletal and cardio-respiratory systems at high level, removing the age as the limiting factor for performance in long-distance runs.

Finally, we failed to find a significant gender ^{x} age interaction in running performance, which practically implied no variation of gender differences by age group, respectively. Such findings corresponded well with previous evidence, that men and women in certain age groups exhibited similar running times.[4] Based on previous statements, women are close to achieve similar or even better results in long-distance runs, compared to men and age does not seem to influence running performance. Thus, the gender and age combinations may indicate that men in a certain age category display similar running times as women in the same age category.

However, our results are based on one half-marathon run with a relatively small sample size and greater heterogeneity between the study participants. Also, the proportion of men and women in different age categories was not similar, which may have led to a lack of statistical power. Next, we examined age in a 10-year interval period, while previous studies have used a 5-year interval period to obtain more detailed information.[4,10] Thus, future research should advise to use the data from multiple half-marathon runs in a large sample of men and women of different age structured in q 5-year interval, in order to determine gender- and age-specific differences and to provide nomograms for successful running times.

Practical Applications

The gender- and age-specific normative values for running performance obtained in this study can serve various purposes. Runners with slower times, placed in the lowest percentiles, can compare their results to others of the same gender and age group to guide their training interventions. Additionally, performance data from a specific race can be used as a reference for tracking progress throughout the competition period. Lastly, these findings can assist runners and their coaches in monitoring running times, helping to track individual progress under different environmental conditions.

Conclusions

To conclude, this study demonstrates that running times are more significantly faster in men compared to women, as they achieve quicker average times. However, the differences across age groups are minimal, and the gender × age interaction shows only negligible differences, suggesting that the main effects of age and the gender × age interaction do not have a substantial impact on running times. Consequently, further exploration of additional biological and environmental factors influencing personal bests of recreational runners, is needed to deepen our understanding of the elements that contribute to athletic performance optimization.

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Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

Ethical Committee approval

Ethical review board of the Faculty of Science and Education, University of Mostar approved this investigation (ethical approval code: 1/12 - 2024).

Topic

Sport Science

Conflicts of interest

The authors have no conflicts of interest to declare.

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Author-s contribution

Conceptualization, F.L.; methodology, F.L. and M.R.; software, J.L.; validation, J.L.; formal analysis, F.L. and M.R.; investigation, J.L.; resources, J.L..; data curation, F.L. and M.R.; writing—original draft preparation, F.L. and M.R; writing—review and editing, F.L. and M.R.; visualization, J.L.; supervision, F.L.; project administration, F.L. All authors have read and agreed to the published version of the manuscript.

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