

ANALYSIS AND PERFORMANCE TRENDS OF SERBIAN RUNNERS IN THE BELGRADE MARATHON IN THE 2007-2019 PERIOD

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Abstract

The Belgrade Marathon has been held since 1988 and has the longest tradition in the Western Balkans region. The trend in the number of participants in the Belgrade Marathon showed a significant increase in the 2007-2019 period. In addition to the global increase in the number of participants, a decreasing performance trends in marathon races has been noticed. The aim of this paper was to determine the trends in the performances of participants from Serbia in the Belgrade Marathon in the 2007-2019 period. The general cognitive assumption was that with an increase in the number of participants led to a decline in the average performance in the race. The results on the official website of the Belgrade Marathon were used as a source of data for this non-experimental study. All performances of the marathoners from Serbia (n = 3554) in the period 2007-2019 were analyzed. Linear regression analysis was used to assess the trend of the performances of all marathoners from Serbia, their distribution according to age groups by every 10 years, as well as the performances of the 10 first-ranked athletes in total and in each of the groups. The linear trend model on the sample of all marathoners from Serbia has shown that the performance became significantly worse over the years i.e., by 2:14 minutes per year. The trend of a significant decline in performance, ranging from 1:52 to 3:02 minutes per year, has been observed in all age groups of up to 50 years. The linear trend models obtained on the subsamples of the 10 first-ranked men in each of the analyzed age groups did not exceed the level of statistical significance, except in the group of males aged 50-60, where a significant performance trends improvement by 2:10 minutes a year was determined. The performances of competitors from Serbia at the Belgrade Marathon were declining in the examined period, along with a simultaneous increase in the number of participants in this event. It can be assumed that the average performance is declining due to an increasing number of recreational runners participating in the marathon, while the number of categorized runners is not increasing significantly, which in a way reflects conservatism and unchangeability within athletic long-distance races and marathon running events.

Key words: RUNNING/ AGE GROUPS / REGRESSION MODELS

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INTRODUCTION

Running is a physical activity in which a person handles the weight of his or her own body, engaging large muscles, and requiring strength, power, coordination and especially good cardiovascular endurance (Wilkinson, Dunne, Palffy, Sturgeon, & Fox, 2014). It, as the dominant form of aerobic endurance training, leads to effects such as: body fat reduction, increased maximal oxygen consumption, improved running efficiency, increased respiratory capacity, reduced levels of blood lactate concentration at submaximal intensity, increased mitochondrial and capillary density and improved enzyme activity (Swank, and Sharpe, 2018). Running is a natural form of movement, its volume and intensity can be precisely dosed, places for running are accessible, equipment is not expensive, and the positive effects of running on health are obvious (Stojiljković, Mitić, Mandarić, and Nešić, 2012). Research shows that aging, as a biological process, can be significantly slowed down by a number of lifestyle factors, including training and marathon running (Leyk et al., 2009).

The first marathon race was held at the first modern Summer Olympics in Athens in 1896, and the 42.195km distance became official at the London Olympics in 1908 (Burfoot, 2007; Wilcock, 2008). In the 1970s and 1980s, along with the growing trend of health and physical fitness and recreational exercises in general, there was a great expansion of marathon events, which have become increasingly popular (Valentine, 1982; Maffetone, Malcata, Rivera, & Laursen, 2017; Knechtle, Di Gangi, Rüst, Rosemann, & Nikolaidis, 2018). Over the past decades, along with an increase in the number of events, the number of recreational runners has increased significantly, which is most clearly seen in the analysis of the number of participants in half-marathon and marathon races. The number of participants in marathon races has been growing continuously since the early 1980s, and in recent times the number of women and elderly runners has been growing in particular (Jokl, Sethi, & Cooper, 2004; Lepers, & Cattagni, 2012; Hunter, & Stevens, 2013 ; Burfoot, 2007; Vitti, Nikolaidis, Villiger, Onywera, & Knechtle, 2020; Knechtle, Di Gangi, Rüst, & Nikolaidis, 2020).

The Belgrade Marathon (BG Marathon) has been held since 1988 and has the longest tradition in the Western Balkans region. Demographic data of participants in the "BG Marathon" follow global trends today with a delay of a decade or two. Primarily it follows the trends in the number of participants, especially women, which in the last 13 years has been growing at a rate higher than the one in the world's largest marathons, where a sudden increase in the number of participants occurred earlier, and there has been a stagnation in recent years. The total number of participants from Serbia who ran the "BG Marathon" in 2007 was 81, and after that the number of participants was constantly growing, and in 2019 it amounted to 611 runners. In the 2007–2009 period, the ratio regarding the number of women and men from Serbia ranged from 1:15.2; 1:35 and 1:13.9 (approximately 15, 35 and 14 men, respectively, for every woman who ran the marathon). Ten years later, in the period of 2017-2019, the ratio of women to men was much more favorable for women: approximately 1:7; 1:6.6 and 1:6 - for every 6-7 men, there was one woman who ran the marathon (Stojiljković, Mitić, and Papić, 2019). The gender ratio in marathon races in the world is generally even more favorable for women than in the "BG Marathon". In the period of 2008–2018, the ratio of female and male runners at the Oslo Marathon was 1:3.9 (Nikolaidis, Cuk, Clemente-Suárez, Villiger, & Knechtle, 2021), at the Berlin Marathon in 2018 it was 1:2.3 (Reusser et al., 2021), and at the Boston Marathon in 2016 it was as much as 1:1.2 (Knechtle, Di Gangi, Rüst, & Nikolaidis, 2020).

With an increase in the number of participants, the world has seen a declining performance trends achieved in marathon races (Ahmadyar, Rüst, Rosemann, & Knechtle, 2015; Lehto, 2016; Knechtle, Di Gangi, Rüst, Rosemann, & Nikolaidis, 2018; Vitti, Nikolaidis, Villiger, Onywera, & Knechtle, 2020; Reusser et al., 2021). The decline is more pronounced in men, so that the difference in performance between women and men has been decreasing (Knechtle, Di Gangi, Rüst, & Nikolaidis, 2020).

The performance in a marathon race also depends on the age of the runner. The best performances are achieved by marathoners belonging to the age groups of up to 40 years (Reusser et al., 2021) i.e., up to 50 years of age (Zavorsky, Tomko, & Smoliga, 2017), and then the performance declines slowly. During the years of the marathon organization, there has been a decline in the performances of men and women in all 10

years age groups (Reusser et al., 2021) i.e., in all age groups of up to 70 years of age (Knechtle, Rosemann, Zingg, & Rüst, 2015).

The **aim** of this non-experimental study was to analyze and determine the performance trends of marathoners from Serbia at the "BG Marathon" in the 2007-2019 period. The general cognitive assumption was that with an increase in the number of participants, the average performances in the race decreased during the calendar years. It was also assumed that there is no difference in the trend of performance between participants in different age groups.

METHOD

The results found on the official website of the "BG Marathon" were used as a source of research data. The year of the race, gender, age, country the competitor appeared for, ranking and performance in the race were selected and analyzed. Data have been monitored since 2007, since when the official records on the race participants contain data on the country the participants come from. The performances of marathoners from Serbia were analyzed, a total of 3554 results, who in the period of 2007-2019 finished the race within the time limit of 6 hours (only in 2007 the limit was 5 hours). The performances were singled out separately by age groups of every 10 years, including the performances of the 10 first-ranked men achieved in the examined period.

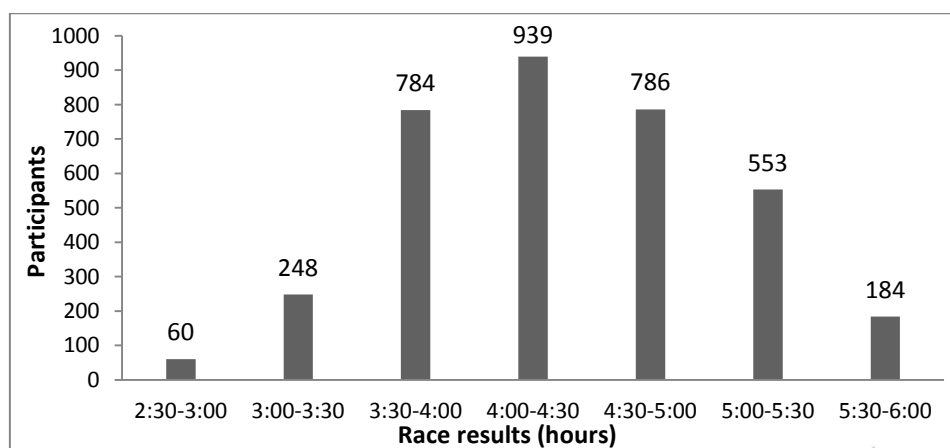
The paper did not analyze the performances of female marathon runners from Serbia, because although constantly increasing, the number of female marathoners is still quite small, in the first eight years of the analyzed period it was below 20, and in the last 5 years the number of women running the "BG marathon" increased from 42 in 2015 to 87 in 2019 (Stojiljković, Matić, & Papić, 2019).

Statistical Data Processing

The results were processed using SPSS 21.0 software (SPSS Inc, Chicago, IL, USA) and Office Excel 2010 (Microsoft Corporation, Redmond, WA, USA). Descriptive, comparative and regression statistical attributes of the sample were singled out. From the field of descriptive statistics, the basic central and dispersion parameters were calculated: arithmetic mean (AS) and standard deviation (SD). Single modality factor analysis of variance (Single Factor ANOVA - Post hoc Tukey HSD), examined the significance of differences in the average marathon performances, between five age groups of every 10 years, on the sample of all marathoners and on the subsample of 10 first-ranked marathoners in each age group. Linear regression analysis was used to assess the performance trends of all men from Serbia; of men by age groups of every 10 years, in the groups which included at least 10 men who ran the marathon; 10 first-ranked men from Serbia in total; 10 first-ranked runners in each of the age groups including at least 10 men who ran the marathon (except for 2012, since there are no data on the age of the runners available for this year). Evaluation of the statistical significance of differences was determined at the level of $p < 0.05$.

RESULTS

Graph 1 shows the performances of participants from Serbia who ran the "BG Marathon" in the period of 2007-2019 ($n = 3554$). The registered results were divided into time intervals of 30 minutes each. It can be seen that in the analyzed period of 13 years, no man from Serbia ran the "BG Marathon" in less than 2:30 hours (150 minutes). The largest number of examined participants ran the marathon race in the interval of 4-4:30 hours i.e., 939 marathoners (26.4%), and there were 22% of runners who were half an hour faster or slower respectively. A total of 8.7% of marathoners from Serbia ran the marathon faster than 3:30 hours, (only 1.7% under 3 hours), and the remaining 20.7% ran in the interval of 5-6 hours.



Graph 1. Distribution of participants from Serbia according to the performances in the "BG marathon" in the analyzed period

Table 1 shows the performances of participants from Serbia who ran the "BG Marathon" in the 2007-2019 period by the year of the event, in total (n = 3554) and by age groups (n = 3368, since there are no data available on the age of participants for 2012). The largest number of participants was determined in the age group 30+ (30-40 years) - 1098 marathoners (30.9%); slightly smaller number in the -30 group (up to 30 years) - 1000 marathoners (28.1%); while the number of marathoners aged over 40 has been constantly and linearly declining. The average age of all marathoners from Serbia in the period of 2007-2019 was 37.1 ± 11.6 years, and the linear trend model and the linear regression formula showed that there was no significant trend of change ($p = 0.517$), so it can be concluded that the average age of participants from Serbia in the "BG Marathon" did not vary in the examined period.

Table 1. Performance of participants from Serbia in the "BG Marathon" in the 2007-2019 period, in total and by age groups

		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	ALL
-30	n	20	31	45	35	44		73	104	134	132	149	106	127	1000
	AS (min)	246,6	260,6	268,8	279,8	258,9		272,7	277,8	265,7	282,9	269,8	288,4	274,3	273,6
	SD	40,9	40,6	43,7	43,6	36,1		40,1	40,4	41,0	36,5	38,8	41,7	36,7	40,3
30+	n	21	28	31	46	42		68	83	110	128	180	177	184	1098
	AS (min)	220,0	245,7	250,6	253,9	243,0		262,3	266,4	244,2	277,8	256,2	271,2	261,2	260,2
	SD	45,7	41,1	41,3	36,8	36,7		40,5	40,3	37,1	41,5	40,3	41,6	38,0	41,4
40+	n	18	28	27	23	33		43	53	70	81	129	126	141	772
	AS (min)	214,4	241,1	239,4	248,5	241,0		258,7	255,8	240,5	270,0	257,6	269,9	257,8	256,1
	SD	32,5	36,4	41,7	37,5	36,8		30,8	35,6	32,0	37,8	38,7	42,3	38,4	39,4
50+	n	15	14	17	18	22		18	22	33	38	43	47	50	337
	AS (min)	240,7	255,5	256,0	256,9	258,6		257,6	259,1	245,7	275,7	256,8	277,7	259,1	260,6
	SD	22,8	24,9	37,8	25,7	33,6		47,8	42,9	26,8	37,1	37,8	45,9	36,8	38,0
60+	n	2	4	5	6	8		14	14	18	19	25	24	22	161
	AS (min)	232,7	256,1	267,8	268,8	243,5		272,2	272,7	261,2	272,7	265,7	287,5	275,1	270,2
	SD	33,9	38,2	39,2	41,9	43,9		40,4	27,7	30,2	32,1	32,5	34,7	28,2	34,3
ALL	n	76	105	125	128	149	186	216	276	365	398	526	480	524	3554
	AS (min)	230,1	250,6	256,2	261,2	249,6	265,2	265,3	268,4	252,4	277,5	260,9	276,1	263,8	263,8
	SD	38,9	38,0	42,7	39,2	37,0	39,9	39,4	39,8	38,0	38,4	39,2	42,5	37,8	40,5

Note: n – number of participants; AS – arithmetic mean; SD – standard deviation

Regarding the performance, it can be noticed that the best results were achieved by participants in the age group 40+ (40-50 years), and then in the two closest age group (30-40 and 50-60 years of age). It is interesting that the worst performances were achieved by the youngest marathoners (under 30), by 3 minutes worse than performance of the oldest ones (over 60 years of age). The average performance of all

participants, in the examined period of 13 years, was 4:23:48 (263.8 minutes), and in terms of calendar years, the best performance was achieved in 2007 (when there were the fewest participants) - 3:50:06. The worst performance was registered in 2016 (4:37:30).

The statistically determined significance of the differences in the average performances in the "BG marathon" between different age groups was verified by analysis of variance, which showed that there are significant differences between specific age groups (Table 2). Although the best average performance was achieved in the 40+ age group (about 4 minutes better than the neighbouring two groups), there is no significant difference between the performances achieved in these three groups. The worst performances were achieved by marathoners under the age of 30 and by those over 60 years of age, and there is also no significant difference found between these two age groups (although the older ones had a 3:29 minute better performance than the younger ones). There are statistically significant differences between the age group 30- and all other age group except the oldest one, as well as between the oldest one and the two age groups with the best performances (30+ and 40+). Based on the results, it can be concluded that at the "BG Marathon" in the 2007-2019 period, participants aged 30-60 achieved significantly better performances than younger and older participants, who did not differ from each other.

Table 2. Comparison of the average performances of participants from Serbia by age groups in the "BG marathon" in the analyzed period

Multiple comparison						
Dependent variable: Performance in the marathon (<i>Tukey HSD</i>)						
Age groups All (n=3368)		Average difference (min)	Standard error	<i>p</i>	95% Confidence interval	
					Lower limit	Upper limit
-30	30+	13,432***	1,747	0,0000	8,663	18,201
	40+	17,511***	1,915	0,0000	12,284	22,738
	50+	13,028***	2,518	0,0000	6,156	19,899
	60+	3,484	3,394	0,8433	-5,781	12,748
30+	40+	4,079	1,877	0,1905	-1,046	9,203
	50+	-0,405	2,489	0,9998	-7,198	6,389
	60+	-9,949*	3,373	0,0266	-19,155	-0,742
40+	50+	-4,483	2,610	0,4230	-11,606	2,640
	60+	14,027***	3,463	0,0005	-23,479	-4,575
50+	60+	-9,544	3,830	0,0926	-19,996	0,908

Note: n – number of participants; *p* – statistical significance

* – average difference is significant at the level of 0.05; *** – average difference is significant at the level of 0,001

Table 3 shows the performances of the 10 first-ranked competitors from Serbia who ran the "BG Marathon" in the period of 2007-2019, by the year of the event, in total and by age groups (except in 2012, as there are no data on the age of participants). In the age group of 60+ years of age, the number of those who crossed the finish line has been higher than 10 since 2013 only, so there are no results available for the previous period. Unlike the average performances of all competitors by age groups, where the fastest ones were included in the age group of 40-50 years (Table 1), considering only the 10 first-ranked runners, it can be noticed that the best scores were achieved by slightly younger marathoners in the age group of 30+ (30-40 years), and followed by the two closest age groups (40+ and 30-). The worst results were achieved by the marathoners included in the two oldest age groups (50+ and 60+). When observing the average performance of the 10 first-ranked runners regardless of their age groups, the best performance was achieved in 2007 - 2:44:36, and the worst performance was in 2010 - 3:12:12, while the average performance of the 10 first-ranked runners was almost three hours exactly - 3:00:24 in all years during the examined period.

Table 3. Performance of the 10 first-ranked participants from Serbia in the "BG Marathon" in the 2007-2019 period, in total and by age groups

		2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Average of all years
-30	AS (min)	217,2	216,2	204,8	228,4	213,4		206,3	201,9	191,2	218,8	209,1	207,1	201,9	209,7
	SD	37,7	30,3	32,2	24,5	11,5		21,5	16,8	19,8	13,6	3,7	13,8	13,8	
30+	AS (min)	178,6	200,1	206,9	202,9	198,5		200,6	205,1	182,1	203,4	175,3	188,3	188,6	194,2
	SD	21,1	22,1	20,7	13,6	14,5		20,6	10,2	14,1	8,4	15,3	17,3	9,9	
40+	AS (min)	188,7	204,7	199,5	218,9	199,7		219,1	206,3	193,0	208,9	193,2	191,0	189,2	201,0
	SD	16,1	11,4	13,2	16,1	17,7		12,9	14,1	17,6	19,9	9,9	13,1	12,7	
50+	AS (min)	228,4	243,5	231,2	239,0	231,1		226,6	220,3	214,7	231,3	209,0	219,0	208,3	225,2
	SD	16,9	16,9	15,6	17,6	18,0		34,7	19,8	13,4	25,5	12,8	18,2	15,3	
60+	AS (min)							252,4	260,0	241,5	248,9	237,0	254,1	251,1	249,3
	SD							23,2	18,7	14,7	11,9	16,3	24,8	20,6	
ALL	AS (min)	164,6	181,4	178,0	192,2	183,8	191,7	180,7	187,6	168,4	189,0	172,6	176,4	178,3	180,4
	SD	8,1	14,9	15,8	11,3	7,7	9,8	14,2	11,0	9,3	10,1	13,1	6,6	8,4	

Note: AS – arithmetic mean; SD – standard deviation

The statistical significance of the differences in the average performances of the 10 first-ranked marathoners, between different age groups, was determined by analysis of variance, which showed that there are very significant differences between all age groups, except between the two fastest age groups of 30+ and 40+ years of age (Table 4). Based on the results, it can be concluded that the 10 first-ranked participants in the "BG Marathon" in the 2007-2019 period, in the age groups of 30-50 years (who did not differ from each other), achieved significantly better results than participants included in other age groups. These two age groups were followed by the group of the youngest athletes (up to 30 years of age), then by the group of older runners (aged 50-60 years) and finally by the oldest marathoners (over 60 years of age). All the differences determined between these groups are statistically significant.

Table 4. Comparison of the average performances of the 10 first-ranked participants from Serbia by age groups in the "BG Marathon" in the analyzed period

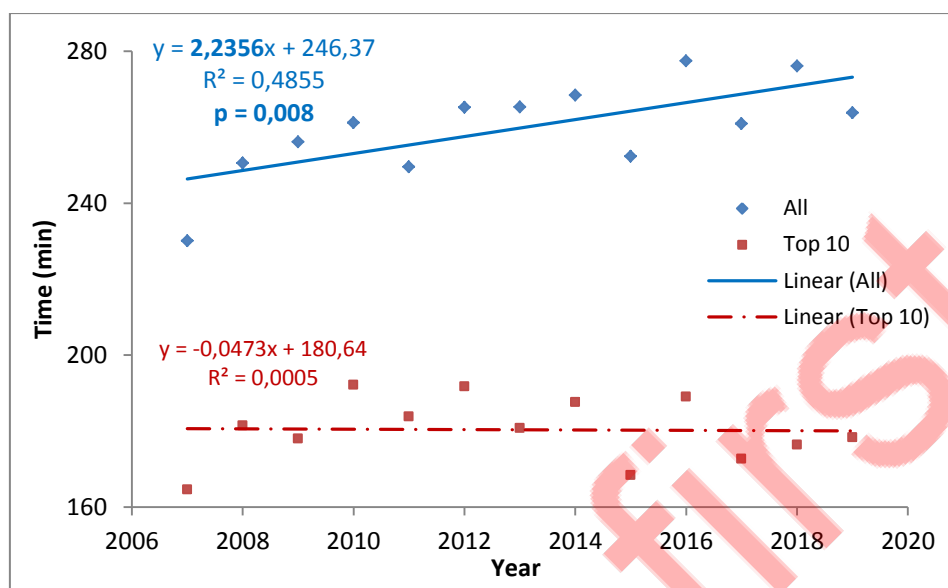
Multiple comparison						
Dependent variable: Performance in the marathon (Tukey HSD)						
Age groups Top 10 (n=550)		Average difference (min)	Standard error	<i>p</i>	95% Confidence interval	
					Lower limit	Upper limit
-30	30+	15,500***	2,614	0,0000	8,346	22,654
	40+	8,692**	2,614	0,0083	1,538	15,845
	50+	-15,533***	2,614	0,0000	-22,687	-8,380
	60+	-39,557***	3,045	0,0000	-47,891	-31,223
30+	40+	-6,808	2,614	0,0709	-13,962	0,345
	50+	-31,033***	2,614	0,0000	-38,187	-23,880
	60+	-55,057***	3,045	0,0000	-63,391	-46,723
40+	50+	-24,225***	2,614	0,0000	-31,379	-17,071
	60+	-48,249***	3,045	0,0000	-56,583	-39,915
50+	60+	-24,024***	3,045	0,0000	-32,358	-15,690

Note: n – number of participants; *p* – statistical significance

** – average difference is significant at the level of 0.01; *** – average difference is significant at the level of 0.001

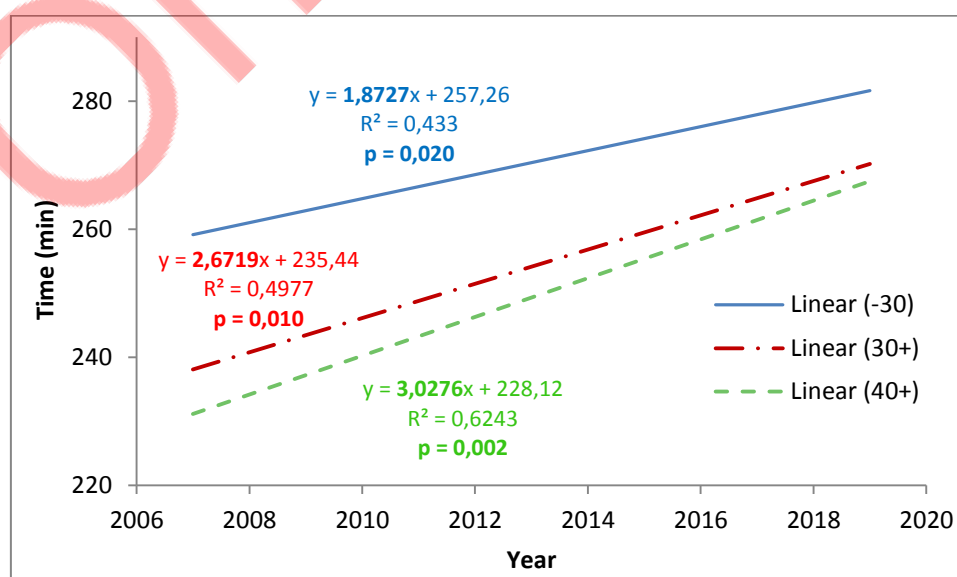
Graph 2 shows the performances by years, linear trend models and linear regression formulas of the results of all participants from Serbia and of the performances of the 10 first-ranked marathoners from Serbia, in the period of 2007-2019. In the examined period, there was a significant trend of the race time

increasing by about 2:14 minutes per year ($p = 0.008$), determined on the total sample, which means that the performances are getting worse. There was no statistically significant trend of change in the performances determined on the sample of the 10 first-ranked marathoners from Serbia, therefore, it can be said that the performance of the best marathoners from Serbia is stagnating. Of course, it is only about the running time, whereby the variable time parameters on the constant course of the "BG Marathon" were not analyzed.



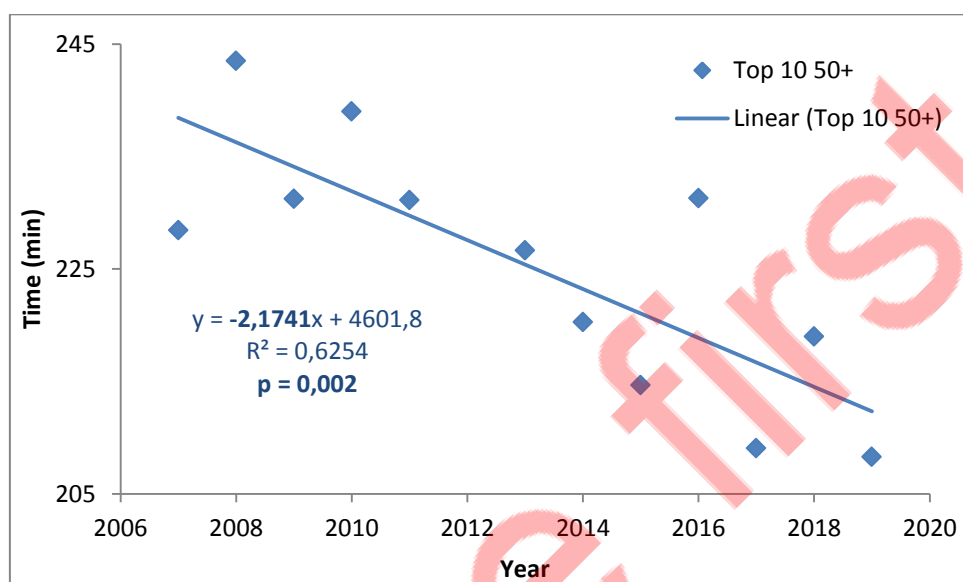
Graph 2. Performance trends of all and top 10 participants from Serbia in the "BG marathon" in the analyzed period

Graph 3 shows the linear trend models and linear regression formulas of the sample results in which there was a significant trend of change in performances determined in the 2007-2019 period. In the examined period, in the three age groups under 50, which together made up about 85% of all marathoners from Serbia, there was a significant trend of increasing the race time, which is in line with the general trend. The increase in the course running time ranged from 1:52 minutes per year in the group of under 30 ($p = 0.02$), over 2:40 minutes in the group of 30-40 ($p = 0.01$), to 3:02 minutes per year in the group of 40-50 years of age ($p = 0.002$). In the two age groups over the age of 50, there was no statistically significant trend of change in the performances, so it can be said that the performance of older marathoners has not changed statistically significantly.



Graph 3. Performance trends of participants from Serbia in the age groups of up to 50 years at the "BG marathon" in the analyzed period

Graph 4 shows the performances by years, linear trend model and linear regression formula of the performances of the 10 first-ranked marathoners from Serbia in the group of 50-60 years of age, in which there is a significant trend of positive change in the performances in the 2007-2019 period. In the examined period, there was a significant trend of the race time decreasing by about 2:10 minutes per year ($p = 0.002$) determined in this group, which is contrary to the general trend. In all other age groups, there was no statistically significant trend of change in the performance found in the top 10 marathoners, so it can be said that the results are relatively stable with a tendency to stagnate.



Graph 4. Performance trends of the top 10 participants from Serbia in the group of 50-60 years at the "BG Marathon" in the analyzed period

DISCUSSION

Performance of all competitors

The largest number of participants from Serbia in the "BG Marathon," in the 2007-2019 period, was included in the age group of 30-40 years ($n = 1098$), a slightly smaller number were in the group of up to 30 years ($n = 1000$), while the number of participants in the age groups of over 40 years of age was significantly smaller and declining linearly (Table 1).

The average age of marathoners from Serbia in the examined period was 37.1 ± 11.6 years. The average age of all men from Switzerland who ran the marathon in all races in Switzerland, in the period of 1999-2014 ($n = 35084$), was 41.8 ± 10.5 years, and the age of women ($n = 8376$) was almost identical: 41.9 ± 10.7 years (Knechtle, Nikolaidis, Onywera, Zingg, Rosemann, & Rüst, 2016). The average age of all men who ran the marathon in New York in the 1970-2017 period ($n = 825186$) was 41.7 ± 9.2 years, while women ($n = 349145$) were slightly younger: 39.7 ± 8.7 years (Vitti, Nikolaidis, Villiger, Onywera, & Knechtle, 2020). It can be concluded that the "BG marathon" participants were, on average, five years younger than the participants in the marathons in Switzerland and New York. This is understandable considering an increase recorded in the number of participants from Serbia in the "BG marathon" in all age groups, with a greater growth dynamics demonstrated in the group of 30-40 years, and a slower one in the age group of 50-60 years. In this group, a relative decline in the number of participants was registered in relation to the total number of participants in the "BG Marathon" (Stojiljković, Matić, and Papić, 2019).

The average course running time - the performance of all participants from Serbia, who ran the "BG Marathon" in the period of 2007-2019 was 4:23:48 (Table 1), and accordingly, the largest number of participants (26.4%) ran the course in the interval of 4-4:30 hours (Graph 1). Although it is difficult to

compare the results achieved in different marathon races due to numerous exogenous factors (race date, climate conditions, latitude, altitude, course configuration, number and quality of participants, etc.), however, for a more thorough understanding of the "BG marathon" trend we have listed the results of several major world marathons. The average performance of all men who completed the Boston Marathon, in the 1997-2017 period ($n = 242636$), was 3:45:38 (Knechtle, Di Gangi, Rüst, Rosemann, & Nikolaidis, 2018). In the same marathon, the average performance of all men was 3:48:38 in the 2002-2012 period ($n = 119343$), or 3:44:04 in the period of 2012-2017 ($n = 83386$) (Knechtle, Di Gangi, Rüst, & Nikolaidis, 2020). The average performance of all men who completed the marathon in New York, in the 1970-2017 period ($n = 825186$), was 4:15:31, but it has a growing trend, therefore, the average performance in the 2000-2017 period was about 4 hours and 23 minutes (Vitti, Nikolaidis, Villiger, Onywera, & Knechtle, 2020). It can be concluded that the average performance of participants from Serbia in the "BG Marathon" was almost identical to the average performance of marathoners in New York, while it was by 35-40 minutes worse than the performance of participants in Boston, in a similar calendar period.

When observing performances of the best competitors, the average performance of the 10 first-ranked men from Serbia in the "BG Marathon," in the 2007-2019 period, was almost three hours exactly - 3:00:24 (Table 3). In the period of 1972-2017, the average performance of the 10 first-ranked men in the Boston Marathon was by far better - 2:13:30 (Knechtle, Di Gangi, Rüst, & Nikolaidis, 2020), which can be explained by the fact that the Boston Marathon has a far longer tradition, greater cash prizes and a greater number of top world competitors. The difference in the achieved performances was also influenced by the configuration of the marathon course in Belgrade, which is more demanding, with a larger number of elevations. It is known that performances achieved in the Boston Marathon cannot be recognized as world records since the course does not meet two standards of the International Association of Athletics Federations (IAAF): 1) it is one-direction course, so the wind might blow in the competitors' back all the time (according to the rules, the start and finish points must be further apart than 50% of the race distance, measured along a theoretical straight line between them i.e., 21.1 km); 2) elevation drop between the finish and the start is not valid (maximum drop in elevation must not exceed 1m above sea level per 1 kilometer of the course i.e., 42m elevation drop between the start and the finish), thus, slopes prevail in the Boston marathon course (Maffetone, Malcata, Rivera, & Laursen, 2017).

Characteristics of the "BG marathon" by age groups

Viewed by age groups, the best average performance in the BG marathon in the 2007-2019 period was achieved by runners in the age group of 40-50 years (4:16:06). The performances achieved in the two neighboring age groups analyzed (30-40 and 50-60 years) were not significantly worse either. The participants in the age groups of 60+ and 30-, who did not differ from each other in terms of results (Tables 1 and 2), were significantly slower. When examining the 10 first-ranked runners by age groups, the marathon runners aged 30-50 achieved significantly better results. The performances achieved by these two groups did not differ statistically, although those included in the 30+ group (average performance 3:14:12) were almost 7 minutes faster than the participants in the group of 40+. According to the performance dynamics, they were followed by the group of 30-, then 50+ and finally 60+ (Tables 3 and 4).

In regard to the comparative approach to the cognitive problem in this study, it is important to point out the conclusions of the Berlin Marathon survey. Examining all competitors by age groups, as well as the five first-ranked runners by age groups, the best performances were achieved by men and women in the age groups of up to 40, and then the performances decreased slightly (Reusser et al., 2021). In addition to Berlin, when observing the average performances of all marathoners by age groups, at the marathons in New York, Boston and Chicago, in the period of 2001-2016, no statistically significant differences were found in men in the groups of up to 50 years of age, while the performances decreased after the age of 50 (Zavorsky, Tomko, & Smoliga, 2017). In the sample of all men who completed 50km-distance races around the world in the 1975-2016 period ($n = 370369$), the best performances were achieved by men in the group of 30-35 years of age, but in the sample of 10 first-ranked runners by age groups, the best performances were determined in the group of 35-40 years (Nikolaidis, & Knechtle, 2018). The results of the mentioned studies are similar to

the findings of this study, which determined that the best performances were achieved by the competitors who were slightly older (aged 40-50) while the participants aged 30-40 (or 30-50 in a wider range), demonstrated superior performance among the 10 first-ranked athletes. It can be expected that the trend of increasing the number of participants, especially in the 30+ age group, will lead to a shift of the best performances towards younger age groups at the "BG marathon".

General trend of change in the performance

On the sample of all participants from Serbia, the linear trend model has shown that, in the examined period of 2007-2019, the performances were getting worse from year to year, with a deteriorating trend of about 2:14 minutes per year (Graph 2). In line with this trend, a significant decline in the performances (in the range of 1:52–3:02 minutes per year) has been observed in all age groups of up to 50 years (about 85% of participants from Serbia) (Graph 3). In marathoners over the age of 50, the performances did not change significantly.

In the 1972–2017 period, the average performance achieved by all men at the Boston Marathon decreased from 3:01:07 in the 1972-1982 period ($n = 23777$) to 3:48:38 in the 2002–2012 period ($n = 119343$) i.e., 3:44:04 in the period of 2012-2017 ($n = 83386$) (Knechtle, Di Gangi, Rüst, & Nikolaidis, 2020). When comparing the last two 20-year periods, the performances of all men who completed the Boston Marathon were 20 minutes slower on average: in the 1977-1997 period the average performance was 3:25:51, and in the period of 1997-2017 the performance was 3:45:38 (Knechtle, Di Gangi, Rüst, Rosemann, & Nikolaidis, 2018). Although the performances achieved by men in the Boston Marathon were much better than the performances of runners from Serbia in the "BG Marathon" in a similar period examined, the trend of performance was identical, declining, with an increase in the number of participants. The performances of men and women in the Berlin Marathon were constantly declining in the 1974-2019 period, both in the total sample and in all age groups (Reusser et al., 2021), which is similar to the results of this study, which shows a declining performance trends in the age groups of up to 50 years, which comprised about 85% of all participants. In two marathons in Switzerland (Lausanne City Marathon and Jungfrau Mountain Marathon), the number of participants, males and females, increased in most age groups in the period between 2000 and 2014. At the same time, the performances were getting worse over the years, in all groups of up to 70 years of age (except in the category of 25-30 years at the Lausanne Marathon, where there were no significant changes) (Knechtle, Rosemann, Zingg, & Rüst, 2015). The performances of all men ($n = 370369$) and women ($n = 124045$), in 50km-distance races around the world, were constantly declining in the 1975–2016 period, with a simultaneous large increase in the number of participants (Nikolaidis, & Knechtle, 2018). The mentioned studies have shown a trend very similar to the trend determined at the "BG marathon" i.e., the average performance has become significantly worse over the last decades, along with a significant increase in the number of participants. In recent decades, the number of participants in marathons around the world has been increasing, mainly due to the number of recreational runners, which is much higher than the number of categorized runners (Lepers, & Stapley, 2016), thus, logically, the average performances are declining, as shown by all previous research. It is noteworthy that the "BG marathon" shows that the performances of competitors over 50 years of age have remained relatively stable with a tendency to stagnate.

Trend of changes in the best competitors' performances

The linear trend model of the 10 first-ranked marathoners from Serbia in the "BG marathon" (Graph 2), as well as the linear models obtained on the subsamples of the 10 first-ranked male runners in age groups, did not exceed the level of statistical significance i.e., the performances stagnated. The exception is the 50+ age group, where the performances of the 10 first-ranked runners, in the 2007-2019 period, showed a significant trend of improvement by about 2:10 minutes per year (Graph 4).

In the 1972-2017 period, the average performance of the 10 first-ranked competitors at the Boston Marathon was 2:13:30, but without a clear trend of changes in the analyzed period. The performances improved from the first to the third decade of the examined period, and then they were getting worse over the following 15 years (Knechtle, Di Gangi, Rüst, & Nikolaidis, 2020). In the period of 1974-2019, there was a

trend of performance improvement determined among the 10 first-ranked male and female runners in the Berlin Marathon, however, examining the period of the last 20 years (2000-2019), almost no changes have been determined (Reusser et al., 2021). It can be said that the performances of the 10 best-ranked runners from Serbia at the "BG marathon" have been stagnating, which is similar to the marathons in Berlin and Boston. However, there are also marathons where a trend of improving the best competitors' performances has been noticed. In the 2005-2014 period, the performances of the 10 first-ranked runners achieved in the races of the WMM - World Marathon Majors, a series which, in the analyzed period, included the marathons in London, Berlin, New York, Boston and Chicago, showed a trend of improvement of ~ 1% over 7 years, as found both in men and women (Maffetone, Malcata, Rivera, & Laursen, 2017). In the 2000-2010 period, at all marathons in Switzerland, the five first-ranked marathoners outside Africa significantly improved their average performances - from 2:27:00 to 2:20:24, as well as the five top-ranked competitors from Africa - from 2:17:00 to 2:13:12 (Aschmann et al., 2013).

When examining the best competitors by competition age groups, the performances achieved in the "BG marathon" have mostly stagnated, but there has been a significant trend of performance improvement determined in the 10 first-ranked runners in the 50+ age group, which is similar to the performances achieved in the New York marathon. In the period of 1983–1999, the performances of the 50 first-ranked male runners in the New York marathon showed a negative trend (performances getting worse) in all groups of up to 50 years of age, while in the groups of over 50 years of age an advance was recorded - performances were getting better (Jokl, Sethi, & Cooper, 2004). The performances of the 10 first-ranked men in the age groups at the New York Marathon did not change significantly in the under-65 groups during the period of 30 years (1980-2009), but the performances of the 10 first-ranked men in the over-65 groups improved significantly. Thus, in the last decade (2000-2009), runners in the group of 65-70 years of age were faster by about 15 minutes than in the first decade examined (1980-1989), and this difference was even greater - about 17 minutes, in the group of 70-75 years of age (Lepers, & Cattagni, 2012).

In order to clarify the analysis of the trends of some running events, it is important to point out that the analysis of athletic races at the distances ranging from 200m to 1500m, in a period longer than 100 years, showed that the progression in performances was initially great, but has now reached a plateau. Further progress is limited by endogenous and exogenous factors of nature and nurture i.e., it can be expected through an increase in the population of runners, more efficient selection, advances in technologies and training methods (Desgorces et al., 2012). A similar conclusion can be reached in respect to the performances achieved in the marathon distance running. However, in recent times, in the 2017-2020 period, all men's and women's world records were broken at the distances ranging from 5km to the marathon, and all record holders were equipped with footwear made by new technology, with a carbon fiber plate inside the soles, which increases running efficiency by more than 4% and long-distance running performance by more than 2% (Muniz-Pardos, Sutehall, Angeloudis, Guppy, Bosch, & Pitsiladis, 2021). Due to the high prices, these running shoes are currently not available to a wider group of marathoners, thus, it cannot be expected that the average performances of all competitors will improve in the near future, under the influence of new marathon running shoes, at least not those achieved in the marathon in Belgrade.

CONCLUSION

The average performance of all marathoners from Serbia who ran the "BG marathon" in the 2007-2019 period (n = 3554) was 4:23:48 (263.8 minutes), and the largest number of participants ran the marathon in the interval of 4–4:30 hours: 939 marathoners (26.4% of all participants). The best average performance was achieved by marathon runners in the 40+ age group (4:16:06); while the youngest marathon runners (under the age of 30) were the slowest: 4:33:36.

The analysis of the linear model trend on the sample of all marathoners from Serbia has shown that, in the examined period of 2007–2019, the performances were getting significantly worse from year to year i.e., by about 2:14 minutes per year. A significant decline in performance (in the range of 1:52-3:02 minutes

per year) was found in all age groups of up to 50 years (about 85% of marathoners from Serbia), while in marathoners aged over 50, the performances were relatively stable with a tendency to stagnation.

The average performance of the 10 first-ranked participants from Serbia, who ran the "BG marathon" in the 2007-2019 period was around 3 hours (3:00:24). When considering the performances of the 10 first-ranked runners by age groups, marathoners in the 30+ category were the fastest ones (3:14:12); whereas, naturally, the oldest participants included in the 60+ age group were the slowest (4:09:18).

The linear model trend of the performances achieved by the 10 first-ranked marathoners from Serbia, as well as the linear models of the 10 first-ranked male runners in the age groups, did not exceed the level of statistical significance, except for one group. In the 50+ group, the performances of the 10 first-ranked runners in the 2007-2019 period have shown a significant trend of improvement, by about 2:10 minutes per year.

The general conclusion of this survey is that the performances of marathoners from Serbia in the "BG marathon" were declining in the period of 2007-2019, with an increase in the number of participants registered at the same time. A more detailed analysis of previous sports experience and preparation programs for the "BG marathon" would direct the cognitive process towards participants and their preferences for running marathons within a group of recreational runners with limited dispositions for their personal progress. The number of those who train regularly, to the optimal extent, as well as the number of registered and categorized athletes - marathoners, is not increasing significantly. It is encouraging that performances of marathon runners aged over 50 are not declining, and 10 first-ranked athletes in the 50+ group are achieving better results, which is contrary to the general trend in both cases. It remains to be seen whether a similar trend will be noticed in some other groups in the future as well.

As the popularity of marathon running continues to grow, such results are of great importance to coaches working with marathoners, as well as to analysts examining differences in long-distance performances in men and women. According to the findings of this and similar studies on trends in the number of participants and performances achieved in marathon events, clubs and coaches should adjust their training programs in accordance with the fact that there are more male and female runners participating in marathon races who are older, and biologically slower, in comparison to previous years.

It would be interesting that future studies determine the trends in performances of all participants in the "BG marathon" including marathoners from abroad or female marathoners, as well as trends in the half marathon race held on the marathon course on the same day.

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