

RUNNING DYNAMICS IN MALE 400M SPRINT EVENT

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Abstract: *The main goal of this research was to determine the running dynamics in male 400m sprint event. This research was conducted on top male athletes who progressed into the finals of four World Championships in athletics: Stuttgart (1993), Athens (1997) Seville (1999) and Berlin (2009). The data for this study was taken from the list of official results and published biomechanical analysis. This research study included 15 variables; 14 of which were time parameters referring to split times at every 50m, at every 100m and at first and last 200m in 400m event, as well as final result, sprinters' age, height and weight. Obtained results were then used to determine basic statistical parameters as well as to determine individual changes in running dynamics of 400m race. Obtained results show miniscule differences in 400m running dynamics that impact better final placement considering the successfulness of movement structure patterns realization.*

Key words: *athletics, sprint, male 400m, running dynamics.*

1. Introduction

The 400m race was once classified as middle distance event, but today it is regarded as a "prolonged sprint". If we consider that Wayde Van Niekerk's one-lap world record of 43.03s (2016) is the equivalent of four consecutive 100m ran in 10.76s this term appears to be well justified. Sometimes the 400m sprint event is also referred to as the "killer event" [13] due to the fact that its

demands push the limits through which a well-trained runner can maintain his or her maximum speed, and a huge stress being placed on the organism with the body invariably fatiguing, "rigging" or "tying up", especially in the closing stage [12]. There are no available research studies concerning male 400m running dynamics. The only data published regarding the 400m sprint event are the

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ones of time parameters of individual parts of 400m event, done in scientific research projects of IAAF (1993, 1997, 1999, and 2009). Running dynamics should be researched in competitive conditions which is not an easy task and can be one of the reasons for lack of published research on this subject.

The aim of this research is to analyze running dynamics in 400m sprint event for elite male sprinters who were finalists of World Championships in: Stuttgart (1993), Athens (1997), Seville (1999) and Berlin (2009).

2. Research methods

Subjects' Sample

Subjects' sample is deliberate and representative, comprised of 32 results of male sprinters (average age 25.50 ± 3.29 yrs; average height 183.12 ± 6.32 cm; average weight 70.24 ± 4.83 kg) who managed to enter the 400m finals of World Athletics Championships in: Stuttgart (1993), Athens (1997), Seville (1999) and Berlin (2009) and who's officially published results of time parameters of running dynamics rhythm in were available. Data used in this research study were extracted from official results' list and published results of biomechanical analyses published on internet web page of IAAF and book by Joch, W. (1997): "Sprint".

2.1. Variables Sample

Variables' sample for this research study was comprised of 18 variables. Instruments for running dynamics/rhythm evaluation were defined by 14 variables of time parameters related to split times at each 50m, at each 100m and at first and second 200m during 400m race. Likewise, this research used the variables: final race time (Result), sprinters' age (DOB),

sprinters' height (Height) and sprinters' weight (Weight).

Data analysis

On analyzed data basic descriptive parameters were calculated: arithmetic mean (AM), minimal result (MIN), maximal result (MAX), total range (TR), standard deviation (SD) and coefficient of variability (VAR). The analysis of running dynamics' changes in 400m event was done by descriptive analysis of individual changes using dynamics indicators with changeable base. Dynamics indicators with changeable base calculate subjects' deviation at certain time point compared to condition at previous time point. Obtained results were used to determine basic statistical parameters as well as to determine individual changes in running dynamics of 400m race.

3. Results

From descriptive parameters (Table 1) it can be seen how the average result of elite male sprinters, finalists of World Championships in 400m event (Result) was 44.77s; the results range from 43,18s to 45,90s. The average age of sprinters was 25.50 years; age ranges from 20 to 32 years. From the results of running dynamics/rhythm parameters (Table 1), from which the structure of competitive activity during 400m event can be observed, it is evident how mean deviation from average results (SD) at every 50m is decreasing by 50-100m segment of the race. At this segment deviation is the smallest, after which it increases by the 100-150m segment and then again slightly decreases at 150-200m segment.

Table 1

Descriptive parameters of running dynamics indicators in final races of 400m event at World Championships in: Stuttgart (1993), Athens (1997), Sevilla (1999) and Berlin (2009)

Variables	AM	MIN	MAX	TR	SD	VAR
0-50m	6.08	5.72	6.30	0.58	0.14	2.30
50-100m	4.96	4.88	5.04	0.16	0.05	1.01
100-150m	5.05	4.91	5.20	0.29	0.09	1.78
150-200m	5.19	5.02	5.30	0.28	0.08	1.54
200-250m	5.36	5.20	5.47	0.27	0.08	1.49
250-300m	5.53	5.24	5.84	0.60	0.15	2.71
300-350m	5.84	5.52	6.08	0.56	0.15	2.57
350-400m	6.37	6.00	6.75	0.75	0.22	3.45
0-100m	11.18	10.74	11.77	1.03	0.24	2.15
100-200m	10.35	10.01	10.73	0.72	0.21	2.03
200-300m	10.99	10.08	11.86	1.78	0.34	3.09
300-400m	12.20	11.52	12.94	1.42	0.38	3.11
0-200m	21.53	20.84	22.43	1.59	0.40	1.86
200-400m	23.22	21.96	24.16	2.20	0.57	2.45
Result	44.77	43.18	45.90	2.72	0.64	1.43
Height	183.12	170	195	25	6.32	3.45
Weight	76.24	66	89	23	4.83	6.34
DOB	25.50	20	32	12	3.29	12.90

Mean deviation at 150-200m and 200-250m segment is equal, after which it increases by the 250-300m segment which is equal to the 300-350m segment of the 400m race. Finally, at the last 50m segment (350-400m) the mean deviation

from average result is the greatest. Similar trend can be observed from the analysis of total range (TR) parameters. From analyzed results it might be concluded that the greatest differences in achieved results at 400m race are between 250m

and 400m. It is the most interesting part of the race as it shows who can preserve optimal technical characteristics of running stride despite intense fatigue in order to be successful [6].

By analyzing mean deviation from results' average at every 100m it can be observed how mean deviation at second 100m, compared to the first 100m decreases, after which, at 300m, increases slightly while at the end of the race, at last 100m is the greatest. On another hand, the range of results at second 100m, compared to first 100m decreases after which at 300m it increases and is the greatest, while at the end of the race, at last 100m the range of results slightly decreases.

By observing first and second 200m of 400m event it might be concluded how the mean deviation from the results' average at first 200m is less than at second 200m, in other words – the greater difference in achieved results was at second 200m. The same trend can be seen in the total range (TR) analysis as well.

Absolute grade of change (Table 2) with changeable base depicts the subject's results' difference at certain time point compared to the result at previous time point. Analysis of results shows how no sprinter had even running rhythm during 400m event. The second segment at 50m was for all sprinters faster than the first one starting from 0.70s to 1.34s, which is also the greatest deviation in running dynamics /rhythm of 400m event.

Mentioned results at first segment at 50m are negatively annotated (Table 2), which means that subject's time results in that control point were of lower values than the results in following time control point. Iwan Thomas as the sixth placed in the final race in Stuttgart (1993) and Jerome Young as fourth placed in Athens (1997) run following 50m segment faster than the previous one; the one from 100m to 150m, which means that their speed increased to 150m, while the speed of the other finalists decreased after 100m of 400m event. If we analyze each 50m segment of 400m event, Davis Kamoga, silver medalist from Athens (1997), run a very interesting race. He run the second 50m segment (50-100m) faster than the first (0-50m), as all other analyzed participants in the World Championships did, then he ran the second (50-100m) and third segment (100-150m) at equal speed, the fourth (150-200m) faster than the previous two (50-100m and 100-150m) by 0.02 seconds, and the difference between the fourth (150-200m) and fifth 50m segment (200-250m) was 0.22 seconds, equal to the difference between the fifth (200-250m) and sixth 50m segment (250-300m). Tyree Washington, bronze medalist from Athens (1997) was the only finalist of all the analyzed World Championship finals that ran the sixth 50m segment (250-350m) faster than the fifth (200-250m) of the 400m race.

Table 2

Running dynamics indicators with changeable base – absolute grade of change

segments names	50-100	100-150	150-200	200-250	250-300	300-350	350-400
Michael Johnson	-1.03	0.22	0.08	0.00	0.12	0.26	0.48
Davis Kamoga	-1.19	0.00	-0.02	0.22	0.22	0.32	0.56
Tyree Washington	-1.07	0.10	0.20	0.16	-0.06	0.40	0.30
Mark Richardson	-0.93	0.22	0.04	0.14	0.16	0.18	0.54
Jerome Young	-1.16	0.08	0.00	0.32	0.08	0.38	0.40
Iwan Thomas	-0.70	-0.08	0.22	0.24	0.28	0.30	0.48
Antonio Pettigrew	-1.34	0.22	0.10	0.00	0.22	0.22	0.36
Jamie Baulch	-1.20	0.12	0.20	0.26	0.38	0.16	0.60
Michael Johnson	-1.18	0.04	0.12	0.08	0.04	0.28	0.48
Carlo Sanderlei Parrela	-1.32	0.01	0.19	0.31	0.15	0.27	0.53
Alejandro Cardenas	-1.01	0.03	0.16	0.21	0.14	0.33	0.48
Jerome Young	-1.14	-0.01	0.17	0.09	0.10	0.46	0.77
Antonio Pettigrew	-1.18	0.11	0.15	0.21	0.20	0.32	0.59
Mark Richardson	-0.18	0.14	0.22	0.12	0.23	0.28	0.60
Gregory Haughton	-1.05	0.06	0.13	0.21	0.27	0.42	0.68
Jamie Baulch	-1.22	0.06	0.27	0.22	0.22	0.39	0.57

Running dynamics indicators with changeable base – absolute grade of change Table 3

segments names	100-200m	200-300m	300-400m	200-400m
Michael Johnson	-0.91	0.1	1.06	0.35
Harry Reynolds	-0.97	0.62	1.08	1.35
Samson Kitur	-1.19	1.54	-0.01	0.88
Quincy Watts	-1.05	0.57	1.26	1.35
Sunday Bada	-0.94	1.20	1.61	3.07
Gregory Haughton	-0.98	0.66	1.53	1.87
Simon Kemboi	-1.12	-0.71	0.51	0.81
Kennedy Ochieng	-0.88	0.71	0.54	1.08
Michael Johnson	-0.51	0.2	1.12	1.01
Davis Kamoga	-1.12	0.64	1.42	1.49
Tyree Washington	-0.67	0.46	1.04	1.29
Mark Richardson	-0.45	0.48	1.06	1.57
Jerome Young	-1.01	0.72	1.24	1.67
Iwan Thomas	-0.64	-0.02	2.36	2.68
Antonio Pettigrew	-0.8	0.32	1.02	1.86
Jamie Baulch	-0.76	1.1	1.3	2.74
Michael Johnson	-0.98	0.32	1.08	0.74
Carlo Sanderlei Parrela	-1.11	0.96	1.22	2.03
Alejandro Cardenas	-0.79	0.72	1.28	1.93
Jerome Young	-0.99	0.45	1.62	1.70
Antonio Pettigrew	-0.81	0.77	1.43	2.16
Mark Richardson	-0.66	0.69	1.39	2.09
Gregory Haughton	-0.80	0.82	1.79	2.63
Jamie Baulch	-0.83	0.93	1.57	2.60
LaShawn Merrit	-0.79	0.48	0.91	1.08
Jeremy Wariner	-0.55	0.50	1.33	1.78
Renny Quow	-0.97	0.16	0.81	0.16
Tabarie Henry	-0.53	0.69	0.91	0.76
Chris Brown	-0.65	0.89	1.72	2.85
David Gillick	-0.65	0.76	1.00	1.87
Michael Bingham	-0.54	0.53	1.36	1.88
Leslie Djhone	-0.64	0.72	1.02	1.82

The results of analyzing every 100m of the 400m race (Table 3) clearly show how the second 100m segment was for all sprinters faster than initial 100m segment. This is also the least deviation in running dynamics/rhythm of 400m event which usually increases every 100m so that at the last 100m segment the deviation is the greatest. Exceptionally, Samson Kitur ran the last 100m faster than the previous 100m, while Simon Kemboi and Iwan Thomas ran the third 100m faster than the previous (second) 100m of the 400m race. By analyzing results' difference at second 200m (Table 3) compared to the first 200m, it can be concluded how more significant results' deviation happened at the second segment compared to the first segment, that is; the speed decrease was between 0.16s and 3.07s.

4. Conclusion

This research study was carried out on deliberate and representative sample of subjects who managed to qualify into finals of 400m event at the World Championships in: Stuttgart (1993), Athens (1997), Seville (1999) and Berlin (2009) and for whom the officially published results of time parameters of running dynamics/rhythm in 400m event were available. The entity sample comprised of 32 results of elite male sprinters (average age 25.50 years; average height 182.12 cm; average weight 76.24 kg).

The subject of this research was to investigate the specificities of 400m running dynamics. The main aim of this research was to analyze running dynamics in 400m event for male sprinters. The research included 15 variables; 14 of which were time parameters referring to

split times at every 50m, at every 100m and at the first and the last 200m in 400m event, as well as final result, sprinters' age, height and weight.

On these data, basic descriptive parameters were calculated. The analysis of running dynamics changes in 400m event was made by descriptive analysis of individual changes using dynamics indicators with changeable base. Obtained results were then used to determine basic statistical parameters as well as to determine individual changes in running dynamics of 400m race. Obtained results vividly show differences between sprinters and between their split times achieved at different 400m race segments that influence better final placement. There is a number of these differences, all of which are equally important for the final result at 400m event; starting from high level of speed abilities, speed endurance, strength, technique and tactics, mental stability and focus and individual competitiveness.

Finally, it might be concluded how obtained results of this research study can be used in sprinters' training process since they imply on importance of certain aspects of technique and tactics maintenance during 400m race.

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