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## Sports speed allocation optimization model research and application in marathon competition

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### ABSTRACT

By consulting document literature, adopt survey and logistic analysis; make research on 117 athletes of master sportsmen and sportswomen competition speed allocation. Research result shows that athletes' first, second, third, fourth, fifth phase performance is higher than whole journey running average performance, the seventh, eighth phase performance is in the reduction trend, competition speed allocation is in constant speed running, athletes' competition process each phase speed percentage overall differences is small and has the same feature, which builds theoretical basis for establishing competition each phase performance quantization mode, adopt formula: target performance\*phase speed percentage=competition whole journey each phase ideal performance, establish men athlete competition performance 2:05:00-2:20:00 women competition performance 2:15:00-2:30:00 each phase performance quantization mode table that is each phase speed allocation table, suggest coaches, athletes to apply established mode comparing competition implementation ideal speed monitoring and allocation, and provide references for creating excellent results.

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### KEYWORDS

Speed allocation;  
Significance test;  
Piece-wise performance;  
Speed fluctuation.

### INTRODUCTION

Modern marathon competition is a special comprehensive sports ability competition that tests athletes' physical quality, psychological quality, technique and tactics level, intellectual level and willpower quality as well as other aspects. Though athletes participant marathon competition can get excellent performance or not suffered multiple factors influences and constraints, in competition process, in competition process, physical ability allocation is reasonable or not then is a key point,

physical ability allocation decides competition whole journey marching speed. At present, excellent marathon players are constantly increasing, athletes' comprehensive gap is constantly reducing, competition competitive degree is fiercer, whether it can make reasonable speed allocation plan before competition and effective implementation in competition tend to be the key for athlete winning and creating good results.

In modern sports training theory and practice development process, scholars are constantly making researches and analysis on marathon competitions' speed

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allocation, but research is only proceeding with marathon athletes competitions speed allocation general rules, it hasn't made beneficial actual applied reference data quantitative researches on athletes' speed allocation, and hasn't established each phase performance quantization mode. Therefore, research marathon athletes' competition speed allocation features, put forward marathon athletes' phase speed percentage, establish each phase performance quantization mode that is speed allocation table, and provide reference basis for marathon items' training and competition, it has very important practical significance and practical values.

### RESEARCH RESULTS AND ANALYSIS

Take twice international marathon competitions' mean and women top 10 and men be master sportsmen, women be master sportswomen (women sports levels are relative higher) Chinese and foreign athletes 117 people performance as research objects, from which sportsmen is 61, performance range is 2:07:35—2:17:57, sportswomen is 56, performance range is 2:19:39—2:35:04, sportsmen according to sports level are divided into group A (international master sportsmen) 25 people, group B (master sportsmen) 36 people, sportswomen 56 people as a group.

#### Athletes' each phase performance and speed change percentage (%)

TABLE 1 indicates three groups' athletes' 8 phases' each phase performance and average performance differences, only individual phase is above 40s, the other

phase all fluctuate around 30s; for phase speed change percentage, only individual phase is above 4%, others all lower than 3%, average three groups' athletes first and second half performance differences is 85.33s, gap is extremely small, athletes seize on speed is relative proper.

Above shows as research objects marathon athletes' whole journey competition speed all show constant running features, each aspect proves that in competition, adopting constant running is of certain scientificity, and can keep body aerobic metabolism stability, reasonable use energy and avoid lots of lactic acid accumulation, adjust physical ability applying, reduce energy consumption, it is helpful to get good results, therefore adopt "constant running" can let athletes give their ability into play and create good results.

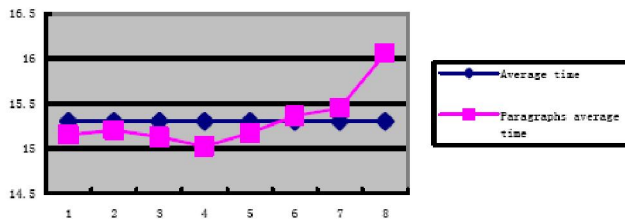
#### Athletes' whole journey competition each phase speed feature

##### Men group A athletes' whole journey competition phases' speed feature

Figure 1 shows that athletes first 5 phases' performance is higher 8 phases' average performance, the fastest phase is the fourth phase; the sixth, seventh, eighth phase performance is lower than 8 phases' average performance, the slowest phase is the eighth phase, worse performance in this phase is because of excessive energy consumption and speed reduction. From above table, it is clear that 8 phases and each phase performance gap the 8<sup>th</sup> phase is 39.58s, other phases all inside 25s, the second phase performance difference is

TABLE 1 : Three groups athletes' 8 phases' performance

Phase	Men group A (N=25)	Men group B (N=36)	Women group (N=56)
1	15:15:21(1.51)	15:58:44(0.88)	17:50:38(0.67)
2	15:20:04(0.83)	16:02:67(0.49)	17:26:08(2.93)
3	15:13:33(1.61)	16:08:12(0.15)	18:21:28(2.17)
4	15:02:87(2.81)	15:58:85(0.83)	17:52:49(0.48)
5	15:17:12(1.19)	15:42:13(2.54)	18:19:55(1.91)
6	15:36:89(1.15)	16:08:24(1.21)	17:41:06(1.54)
7	15:45:46(2.01)	16:18:64(1.21)	18:34:56(3.41)
8	16:06:79(4.22)	16:39:31(3.23)	17:42:57(1.42)
9(2.195km)	6:38:26	7:12:29	7:39:21
First half	1:05:34(1.52)	1:07:01(0.63)	1:15:21(0.43)
Second half	1:07:32(1.68)	1:08:39(0.71)	1:16:01(0.44)

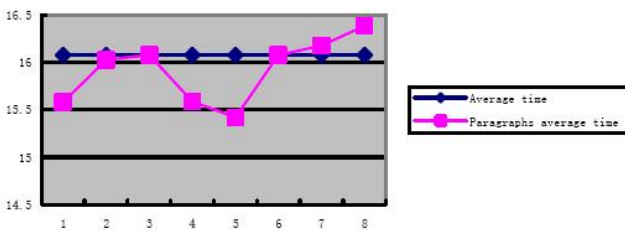


**Figure 1: Men group A athlete phases' performance speed change chart**

only 7s, the fastest phase and slowest phase performance gap is 63.92s, the first and second half differences are 118s. Speed change percentage is larger in the 8<sup>th</sup> phase and is 4.2%, others all within 2.81%, the first half and second half are respectively 1.52%, 1.68%.

**Men group B athletes' whole journey competition each phase speed feature**

From Figure 2, it is clear that men group B athletes' piece-wise performance speed change curve tendency is the same as group B, athletes' previous 6 phases' performance is higher or equal to 8 phases' average performance, the fastest phase is the fifth phase, the seventh, eighth phase performance is lower than 8 phases average performance, the lowest phase is the eighth phase. 8 phases and each phase performance differences in the 8<sup>th</sup> phase is 32.36s, other phases all within 25s, the 3<sup>rd</sup> phase performance differences are only 1.07s, the fastest phase and lowest phase performance difference is 57.18s, the first and second half performance difference is 98s. For speed change percentage, the 8<sup>th</sup> phase is larger that is 3.23%, others all within 2.45%, the first and second half are respectively 0.63%, 0.71%.



**Figure 2: Men group B athletes' phases' performance speed change chart**

**Athletes' whole journey competition each phase percentage feature**

Phase speed percentage (phase performance/whole journey performance×100%) is the reflection of athletes' speed changes in competition. Phase speed percentage can reflect athletes whole journey speed al-

location rules, athletes phase speed percentage is small, indicates the phase speed is faster; on the contrary the speed is slower. Analyze phase speed percentage features can provide theoretical basis for establishing each phase performance quantization mode that is speed allocation table.

**Men group A athletes' each phase speed percentage**

Men group A athlete each phase speed percentage is between 11.31 % and 12.11 %, the maximum swinging difference is 0.8%. 8 phases' average speed percentage is 11.61 %, the first, second, third, fourth, fifth phase speed percentage is lower than average speed percentage, indicates athlete speed in these 5 phases is higher than average speed; the sixth, seventh, eighth phase speed percentage is higher than average speed percentage, indicates athletes speed in these 3 phases is lower than average speed. The first and second half speed percentage are respectively 49.26%, 50.74%, swinging performance difference is 0.48%.

**Men group B athletes' each phase speed percentage**

Men group B athlete each phase speed percentage is between 11.57% and 12.28%, the maximum swinging difference is 0.71%. 8 phases' average speed percentage is 11.88 %, the previous six phases' speed percentage is lower than or equal to average speed percentage, indicates athlete speed in these 6 phases is higher than or equal to average speed; the seventh, eighth phase speed percentage is higher than average speed percentage, indicates athletes speed in these 2 phases is lower than average speed. The first and second half speed percentage are respectively 49.40%, 50.60%, swinging performance difference is 1.20%.

Carry out significance test on men group A, B athletes' each phase speed percentage, data shows two group athletes the fifth phase speed percentage difference has remarkable significance in statistics, other each phase speed percentage all have no remarkable significance, therefore make unified mathematical statistics on research objects' all sportsmen (N =51) phase speed percentage, establish sportsmen each phase speed percentage average value.

**Women group athletes' whole journey competition each phase speed features**

Women marathon athletes' whole journey each

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phase performance fluctuates in 8 phases' average performance, but fluctuation range is smaller. The fastest phase is the second phase, the slowest phase is the seventh phase, difference is 68.48s; 8 phases and each phase performance difference, the seventh phase is the maximum 36.07s, the fourth phase performance difference is the minimum one that is 6s, and the first and second half difference is 40s. Speed change percentage is larger in the 4<sup>th</sup> phase that is 3.14%, all the others within 2.17%, the first and second half are respectively 0.43%, 0.44%.

### Athletes' phases' speed percentage features

Phase speed percentage is the description of marathon athletes' whole journey body internal function

changes generated speed changes' external expression. Athlete piece-wise performance percentage gets smaller, indicates the phase sports speed is faster, on the contrary, sports speed would be slower. According to statistics significance test method, it makes significance test on men and women athletes' piece-wise performance percentage, as following TABLE 2.

Through men and women athletes phase performance percentage significance test, it is clear that men the fifth phase difference has remarkable significance in statistics ( $P < 0.01$ ), other phases differences have no remarkable significance in statistics ( $P > 0.05$  or  $P > 0.01$ ). Women differences in the first, fifth, eighth and first, second half differences all have remarkable significance

TABLE 2 : Men and women piece-wise performance percentage significance test

Phase	Men group A (N=25)	Men group B (N=36)	P	Men group average value(N=61)	Womengroup (N=56)	P
1	11.46	11.77	>0.05	11.63	11.79	<0.01
2	11.52	11.83	>0.05	11.78	11.52	<0.05
3	11.44	11.89	>0.01	11.72	12.13	<0.05
4	11.31	11.78	>0.05	11.62	11.81	<0.05
5	11.48	11.57	>0.01	11.47	12.11	<0.01
6	11.73	11.89	>0.05	11.85	11.68	<0.05
7	11.84	12.02	>0.05	11.89	12.27	<0.05
8	12.11	12.28	>0.05	12.14	11.70	<0.01
First half	49.26	49.40	>0.05	49.31	49.78	<0.01
Second half	50.74	50.60	>0.05	50.69	50.22	<0.01

TABLE 3 : London Olympic Games marathon women top six athletes' phases' speed allocation table(m/s)

Name	0-5	5-10	10-15	15-20	20-h	h-25	25-30
Grana	4.81	4.78	4.79	4.82	4.88	4.94	5.10
Jeptoo	4.81	4.78	4.78	4.83	4.86	4.95	5.10
Arkipova	4.79	4.79	4.78	4.83	4.88	4.91	5.08
Pu the Coss lid	4.81	4.78	4.78	4.83	4.86	4.95	5.10
Sh Milk	4.80	4.78	4.78	4.82	4.86	4.85	4.88
Zhu Xiao-Lin	4.80	4.78	4.78	4.82	4.86	4.85	5.04
	30-35	35-40	40-f	0-h	h-f	0-f	--
Grana	4.98	5.00	5.26	4.80	5.03	4.91	--
Jeptoo	4.97	5.00	5.20	0.48	5.02	4.91	--
Arkipova	5.02	5.00	5.00	0.48	5.00	4.90	--
Pu the Coss lid	4.97	5.00	4.71	0.48	4.97	4.89	--
Sh Milk	4.86	5.02	5.19	0.48	4.93	4.87	--
Zhu Xiao-Lin	4.80	4.90	4.92	4.80	4.91	4.86	--

in statistics ( $P > 0.01$ ), other phases differences all have no remarkable significance in statistics ( $P > 0.05$  or  $P > 0.01$ ). Excellent marathon athletes' phases' performance percentage model got by statistics handling conform to researched objects' overall rules and range, which has certain representativeness and practicability. Coaches and athletes go in for marathon running and long distance running can apply model data, adopt following formula prediction or make whole journey competition speed to define proper phases' running speed and get individual good results. Formula: competition phases' speed = prediction total performance (target performance) \* phases' performance percentage; Simple formula: competition phases' speed = prediction performance (target performance) \* phases' performance percentage average value.

### Athletes' competition each phase performance mode

Marathon athlete whole journey competition speed allocation table established phases' performance percentage mode is established on the basis of summarizing competition excellent Chinese and foreign athletes'

whole journey speed allocation rules, and provides valuable reference for future marathon items' competition training especially speed allocation plan designing, and changes previous only relies on coaches and athletes' intuitive experiences to define phases' speed experiences. In order to more intuitional and convenient to apply data into actual training, set up higher target performance and establish men and women athletes' whole journey speed allocation table.

### Excellent athletes' speed allocation table establishment

Collect recent huge marathon international competition events (London Olympic Games) athlete performance, according to each athlete competition speed allocation feature, phases' speed percentage researches, according to percentage quantization data, combining with London Olympic Games athletes' top six performance, establish men and women marathon athletes' each phase performance quantization mode table that is each phase speed allocation table, as following TABLE 3, TABLE 4 shows:

TABLE 4 : London Olympic Games marathon men top six athletes' phases speed allocation table(m/s)

Name	0-5	5-10	10-15	15-20	20-h	h-25	25-30
Kiprotich	5.42	5.42	5.77	5.56	5.46	5.63	5.49
Kirui	5.41	5.42	5.78	5.56	5.49	5.62	5.49
Kipsang	5.42	5.41	5.88	5.56	5.46	5.55	5.45
Keflezighi	5.41	5.43	5.61	5.42	5.23	5.30	5.38
Santos	5.41	5.43	5.77	5.56	5.49	5.50	5.35
Kenatro Nakamoto	5.39	5.44	5.58	5.35	5.35	5.38	5.38
	30-35	35-40	40-f	0-h	h-f	0-f	--
Kiprotich	5.27	5.51	5.37	5.53	5.45	5.49	--
Kirui	5.27	5.39	5.28	5.54	5.42	5.47	--
Kipsang	5.27	5.21	5.19	5.46	5.30	5.43	--
Keflezighi	5.21	5.24	5.29	5.45	5.28	5.36	--
Santos	5.09	5.06	4.93	5.53	5.20	5.36	--
Kenatro Nakamoto	5.21	5.23	5.16	5.43	5.28	5.36	--

(Note: h is half, f is whole journey)

## CONCLUSIONS

Excellent men and women athletes performances in the first, second, third, fourth, fifth phase are higher

the whole journey running average performance, the seventh, eighth phase performances were in reduction tendency, athletes' competition speeds were featured as "constant running". Excellent men and women marathon athletes overall differences in whole journey com-



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petition each phase speed percentage were smaller, each phase speed percentage had same features, it built theoretical basis for stashing marathon competition each phase performance quantization mode (speed allocation mode). Speed changes had already become marathon and other long distance competitions features, it should targeted carry out speed change tactics training in future training. Athletes according to their features, adopted different speed changes in whole journey every phase to reasonable allocate their physical ability, which was the key to success.

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