

MULTIDIMENSIONAL DYNAMIC OF SPORTS AND TECHNICAL RESULTS IN CROSS-COUNTRY SKIING



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Abstract. This paper deals with the calculation of equivalent results in cross-country skiing. As the result, multi-dimensional dynamic sport and technical results in cross-country skiing are received and tables of equivalent results in which temporal parameters skiers equated points are compiled.

REQUIREMENTS FOR TRAINING FOR THE CLOSE BATTLE IN ARMED CONFLICT FOR A SUBJECT «THEORY AND METHODS OF APPLIED MARTIAL ARTS»

Ключевые слова: *анализ результатов в лыжных гонках, таблицы эквивалентных результатов, динамика соревновательных скоростей.*

Аннотация. В работе проводится расчет эквивалентных результатов в лыжных гонках. В ходе исследования получена многомерная динамика спортивно-технических результатов в лыжных гонках и составлены таблицы эквивалентных результатов, в которых временные показатели лыжников-гонщиков приравниваются к очкам.

Relevance of research. In the system of skiers preparation as well as in other cyclic sports, results analysis is an important tool for solving problems from the formation of long-term training strategy to building microcycle programs. However, analysis of the results of skiers is difficult because the competition factors that determine the speed and retention are changed during the competition: weather conditions (temperature, wind, humidity), the quality of the

slip parameters terrain slopes (slope climbs, descents complexity, the amount of height differences, etc.). Therefore, in addition to skiing, there are time evaluation results, which are expressed in points.

Currently, «Tables equivalent results in cross-country skiing» are used for evaluation of athletic performance (A.G. Batalov, 1999), the content of these tables was based on the results of skiers performance in the late 90s, and the forecast is given up to 2010.

Over the past 15 years many changes in skiing have happened: new technologies of athletic training were introduced, the technique of ski moves improved, and the technique of overcoming the ascents and descents, besides, logistics (skiing equipment and training) improved. In this regard, along with significant variability of results there is also progressive tendency of the best world achievements in cross-country skiing. Annual growth of sports results, achieved by athletes, who are the members of the international «elite» is of about 1% [2]. In this connection new tables of equivalent results are needed.

Objective: to identify the dynamic of sport and technical results at the present stage of cross-country skiing development and to determine their equivalence, depending on the length of distance, competitive style and athlete age group.

Methods: analysis of literary sources; natural experiment; mathematical and statistical methods; method of mathematical modeling.

Research organization. At the first stage, analysis of results of the skiers performance was made for the period from 2005 to 2012 in the age groups from young to basic. Division into age categories was made according to the rules of competition in cross-country skiing [5], the age group elite was chosen from the leaders of the World Cup, World Championships and Olympic Games.

Over 2500 competition protocols were processed at various levels. In each age group the results of both

men and women were concerned at all competitive range. Results, which show winners from 1 to 12 places, were selected from each protocol. It was made because due all the results with respect to higher «record» achievements registered in the international cross-country skiing were needed. Over 30000 individual results were processed.

Based on statistical analysis of modern competitive speeds in all age categories, exponential equation were obtained. These equations describe the regularity of speed changing (m/s), depending on the length of competitive distance (km) in men and women in classic style and freestyle.

Graphical representation of the dynamic of speed of athletes from elite age group is shown in figure 1, equation (1) – (4) describe the patterns obtained.

- Men, freestyle (1)
- Men, classic style (2)
- Women, freestyle (3)
- Women, classic style (4)

At the second stage of the study, analysis of achievements of all ages was made, this analysis defined the dynamic of growth of sports results, which is described by the equation:

Speed is expressed as a percentage of the maximum speed, i.e. speed of elite age group and is age category, expressed in points (fig. 2).

The level of the younger age group was estimated by 200 points, middle – 400 points, senior – 600 and so on, the elite group was assigned the level of 1400 points. This is explained by the fact that further

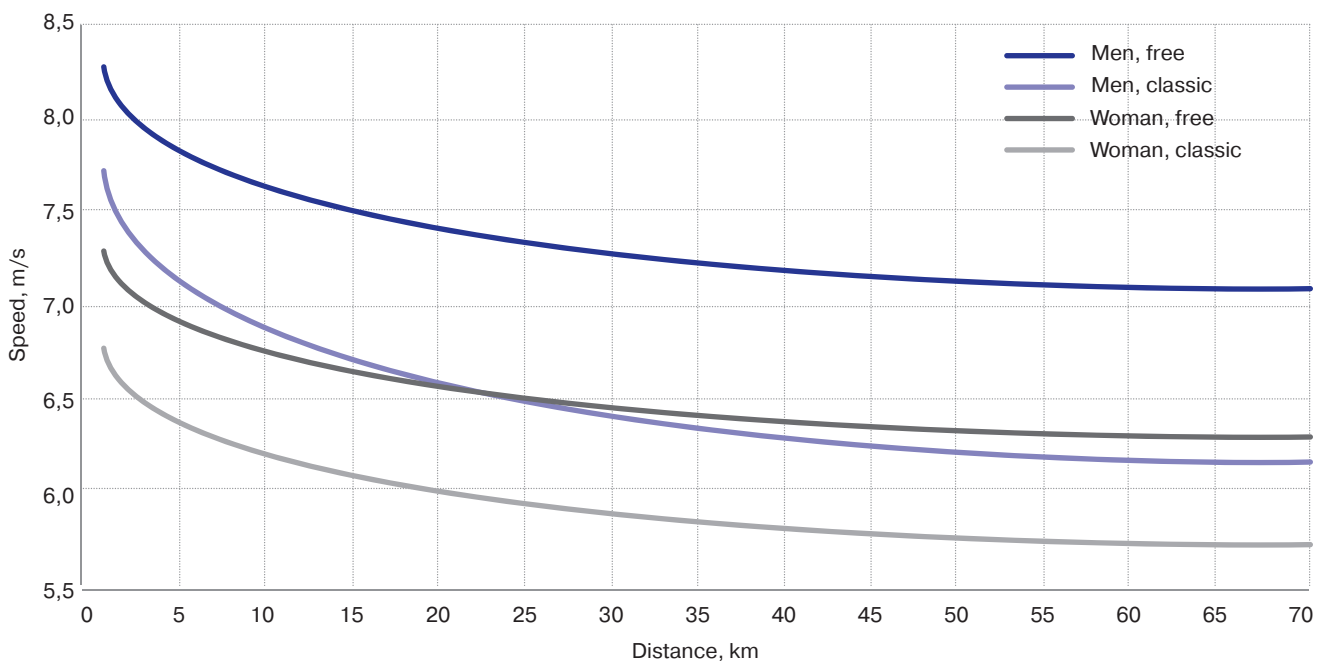


Fig. 1. The dynamic of competitive ski racing speeds (Elite, 2012)

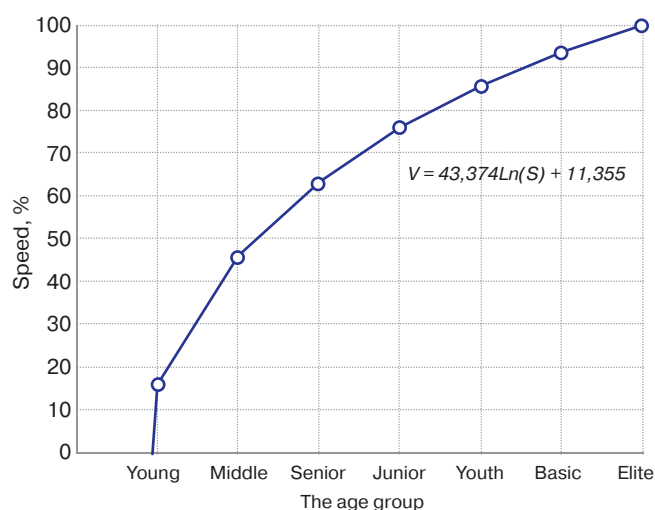


Fig. 2. The dynamic of growth of ski racing results

improvement of results is achieved with great effort. Furthermore, it is necessary that transition from one to another age group (improving effect) should be systematic.

After that, the speed of men in freestyle races in all age groups was analyzed and by using statistical techniques, derive equations of the third degree were obtained. These equations made possible to calculate the speed at given distance by using given points. Score equivalence levels of performance at a distance of 15 km freestyle men is as follows:

$$V = -3,834069865 \cdot 10^{-10} \cdot S^3 + 5,430266955 \cdot 10^{-7} \cdot S^2 + 0,002881810666 \cdot S + 3,666643651$$

Analogically, the evaluation of result's level for men on the main distance was made for both free and classic styles, as well as for women in the same free and classic styles.

At the third stage of the work, tables of equivalent results for men and women in the races classic and free styles were directly compiled, based on estimates of equivalence levels of performance were directly (tabl. 1, 2).

Table 1

Table of equivalent results (time, s) of cross-country skiing, freestyle, men, 2013–2018 years

The age group (points)	1 km	5 km	10 km	15 km	30 km	50 km	70 km
Young (200)	03:30,0	18:14,9	37:57,5	58:39,7	2:04:20	3:36:08	5:10:09
Middle (400)	03:05,8	16:04,0	33:15,7	51:12,8	1:47:43	3:06:11	4:26:15
Senior (600)	02:46,3	14:20,0	29:33,8	45:23,1	1:34:54	2:43:19	3:52:56
Junior (800)	02:31,0	12:57,8	26:39,3	40:49,7	1:24:59	2:25:45	3:27:28
Youth (1000)	02:18,7	11:52,9	24:22,5	37:16,1	1:17:18	2:12:14	3:07:55
Basic (1200)	02:09,1	11:02,2	22:36,2	34:30,6	1:11:23	2:01:52	2:52:59
Elite (1400)	02:01,7	10:23,5	21:15,1	32:24,6	1:06:54	1:54:02	2:41:44
Forecast to 2015 year (1600)	01:56,3	09:55,0	20:15,6	30:52,5	1:03:38	1:48:21	2:33:35
Forecast to 2018 year (1800)	01:52,6	09:35,9	19:35,6	29:50,6	1:01:27	1:44:33	2:28:07

Table 2

Table of equivalent results (time, s) of cross-country skiing, classic style, women, 013–2018 years

The age group (points)	1 km	3 km	5 km	10 km	15 km	30 km	50 km
Young (200)	04:01,1	12:26,3	21:18,3	45:02,8	10:29,5	2:33:09	4:31:13
Middle (400)	03:36,0	11:06,5	18:58,3	39:51,7	02:04,3	2:13:29	3:54:29
Senior (600)	03:15,6	10:01,9	17:05,6	35:44,1	55:25,8	1:58:15	3:26:27
Junior (800)	02:59,1	09:10,0	15:35,3	32:27,6	50:11,4	1:46:24	3:04:53
Youth (1000)	02:45,9	08:28,4	14:23,3	29:52,0	46:04,0	1:37:11	2:48:15
Basic (1200)	02:35,3	07:55,6	13:26,6	27:50,1	42:51,0	1:30:03	2:35:28
Elite (1400)	02:27,2	07:30,2	12:42,8	26:16,4	40:23,3	1:24:38	2:25:47
Forecast to 2015 year (1600)	02:21,2	07:11,4	12:10,4	25:07,3	38:34,5	1:20:42	2:18:44
Forecast to 2018 year (1800)	02:17,1	06:58,6	11:48,3	24:20,4	37:21,0	1:17:59	2:13:59

Discussion of results. Analyzing the dynamic of competitive speed, it should be noted that in all age groups except the main and elite women's speed is slower than men at corresponding distances. However, in the basic age group at distances greater than 43,5 km, women's speed in freestyle exceeds men's speed in a classic style. And in the elite group excess of women's speed in freestyle above men's speed in classic style occurs at distances over 21 km (fig. 1).

With increasing distance from the expressway to the marathon, speed drops by on an average of 1 m/s. So, men's speed at a distance of 1 km in freestyle is 8,21 m/s and at a distance of 70 km – 7,21 m/s. Women's speed at a distance of 1 km in classic style is 6,79 m/s, and at a distance of 50 km – 5,72 m/s.

Speed difference between the classic and freestyle increases with the athlete's age. So, among the boys of younger age group the difference is about 4%, while in the elite group of men – about 11%.

The speed difference between men and women at the corresponding distances with increasing age remains constant and equal to about 15%. So men's speed at a distance of 15 km in freestyle is 7,71 m/s, and the rate of women – 6,8 m/s. The speed at the same distance in the classic style for men is 7,18 m/s and the rate of women – 6,19 m/s.

Studies allowed to develop a table of equivalent results that assess higher recent results for the classic and for free style. These tables allow you to predict the trends of increase of athletic performance for the period of 2013–2018 years. The upper boundary of the estimated results is 1800 points. This level is the

level of expected results for skiers international elite in 2018.

Conclusions

Tables of equivalent results allow to assess results on non-standard distances and assign points to the difference in 1 point.

Equivalent evaluation, expressed in points, allows to determine the level of athletes preparedness, ranging from young category (200 points) to the level of the international elite (1400 points), to do the rating assessment of the individual and team results for a series of events, during the entire competition period, as well as long-term competitive activity.

Calculated tables provide forecast of competitive speeds for the next 5 years, these tables make it possible to implement a model-oriented approach in the planning of the skiers training process.

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