

TACTICS OF TOP-LEVEL COMPETITORS IN CROSS-COUNTRY SKIING

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Abstract:

The aim of the work is to analyze the characteristics of tactics of the top-level competitive skiers in long-distance ski racing. We have analyzed the competitive activity indices of the highly proficient male and female competitive skiers who participated in the Winter Olympics in Albertville, Lillehammer and Nagano, and in the World Skiing Championship in Trondheim (Norway) in 1997. The indices were as follows: average distance speed, changes in gliding speed over separate legs, and changes in placings after different legs. We have also examined the changes in the split times of covering the first and the second leg of a 30-km race. It has been determined that both male and female skiers who develop a higher speed in the middle of the race glide faster in the slower and faster intervals of their races in comparison to the skiers whose average distance speed is lower.

The study has shown that the speed in the first 15-km leg of the 30-km race was lower than in the second lap of the race. The top-ten male competitive skiers in classical style covered the second leg of the distance with a $2.90 \pm 1.37\%$ poorer result in the 30-km race in the Albertville Olympics. The female top-ten competitive skiers in free style, covered the second leg of the race with a $2.97 \pm 2.14\%$ poorer result in the 30-km race in the Lillehammer Olympics. The female top-ten skiers in classical style covered the second 15-km leg of the distance with a $2.79 \pm 1.30\%$ poorer result in the 30-km race in the Lillehammer Olympics.

The following variations of skiers' tactics were determined during the competitions.

- The whole distance is pursued almost equally at individual optimal speeds and skiers try to keep to equal work intensity over the distance.
- Some skiers lose insignificantly to rivals at the beginning of the race. In the middle of the distance they catch up with others, exceed the speed and finally win better places in competitions. This way of gaining a victory over the rivals proved to be wiser than the way in which skiers try to win better places at separate intervals of the first leg of the race.
- The distance coverage is started at high speed. Skiers cover the first kilometers in a leading group. At this point the leaders win against the main rivals, but in the middle of the race and at the finish they are seldom able to keep their gained superiority. Nevertheless, they win high places, but lower than at the beginning of the race.
- The beginning and the middle of the race are gained with high optimal speed; some skiers try to save some energy for the finish and to beat the competitors in the second leg of the race by powerfully gliding through last kilometres. These are strong finishing tactics.
- Skiers with a higher average distance speed glide faster in both the slowest and the fastest intervals of the race than the skiers whose average distance speed is lower.

Elite skiers, competing for medals and placed among the top six, take the leading positions in the first leg of the race and retain them till the end.

Key words: *competitive activity, tactics, classical style, free style, gliding speed, average speed, optimal speed, particular stretches of the course, distance.*

DIE TAKTIK DER SPITZEN-SKILANGLÄUFER

Zusammenfassung:

Das Ziel dieser Studie war, die Besonderheiten der Taktik von Spitzenskilangläufern in einem Skilanglauf-Langstreckenwettbewerb zu bestimmen. Wir haben die Indikatoren der Wettkampfleistung bei den SpitzenskilangläuferInnen analysiert, die an den Olympischen Winterspielen in Albertville, Lillehammer und Nagano sowie an der Ski-Weltmeisterschaft in Trondheim (Norwegen) in 1997 teilnahmen. Die Indikatoren waren die Folgenden: die Durchschnittsgeschwindigkeit auf der gesamten Strecke, die Abwechslung der Gleitgeschwindigkeit auf verschiedenen Etappen und die Abwechslung von gewonnenen Plätzen der Skilangläufer nach bestimmten Etappen. Wir haben auch die Unterschiede in den Durchschnittszeiten in der ersten und in der zweiten Etappe des 30-km-langen Laufes analysiert. Es wurde festgestellt, dass sowohl die Skilangläufer als auch die Skilangläuferinnen, die höhere Geschwindigkeit in der Mitte des Laufes entwickeln, schneller in den langsameren und in den schnelleren Intervallen ihrer Läufe gleiten als die Skilangläufer, deren Durchschnittsgeschwindigkeit auf der gesamten Strecke niedriger ist.

Die Analyse hat gezeigt, dass die Geschwindigkeit in den ersten Etappe (15 Kilometer) niedriger war als in der zweiten. Die zehn besten Skilangläufer, die klassisch laufen, legten die zweite Etappe mit $2,90 \pm 1,37\%$ schlechterem Resultat in der 30-km-langem Lauf in den Winterspielen in Albertville zurück. Die zehn besten Skilangläuferinnen, die Freistiltechnik des Laufens verwenden, legten den zweiten Teil des Laufes mit $2,97 \pm 2,14\%$ schlechterem Resultat in der 30-km-langem Lauf in den Winterspielen in Lillehammer zurück. Die zehn besten Spitzenskilangläuferinnen, die klassische Technik des Laufens verwendeten, legten die zweite 15-km-lange Etappe mit $2,79 \pm 1,30\%$ schlechterem Resultat in 30-km-langem Lauf bei den Olympischen Winterspielen in Lillehammer zurück.

Es wurden die folgenden Variationen der Taktik festgestellt:

- Man läuft über die ganze Strecke ziemlich gleichmäßig mit einer individuell optimalen Geschwindigkeit und versucht, die gleiche Arbeitsintensität zu erhalten.
- Einige Skilangläufer laufen unbedeutend langsamer als ihre Gegner am Beginn des Rennens. In der Mitte holen sie ihre Gegner ein, erhöhen die Geschwindigkeit und letztlich bessere Plätze gewinnen. Solcherart die Gegner zu besiegen ist klüger als zu versuchen, einzelne Abschnitte der ersten Etappe zu gewinnen.
- Man beginnt das Rennen mit einer hohen Geschwindigkeit. Die Skilangläufer legen die ersten Kilometer in der führenden Gruppe zurück. An diesem Punkt haben die Führenden einen Vorsprung vor den Hauptgegnern, aber in der Mitte des Rennens und im Finish sind sie nicht mehr imstande die führende Position zu behalten. Trotzdem gewinnen sie bessere Plätze, obwohl niedrigere als am Beginn des Rennens.
- Man läuft sowohl am Beginn als auch in der Mitte des Laufes mit hoher optimaler Geschwindigkeit. Einige Skilangläufer versuchen, etwas Kraft für das Finish aufzubringen, um besser als ihre Gegner in der zweiten Etappe zu sein, indem sie in den letzten Kilometern kraftvoll gleiten. Das ist die starke Finish-Taktik.
- Die Skilangläufer mit einer höheren Durchschnittsgeschwindigkeit gleiten schneller in den langsamsten und in den schnellsten Intervalle des Laufes als die Skilangläufer mit einer niedrigeren Durchschnittsgeschwindigkeit.

Die Spitzenskilangläufer, die um Medaillen und die ersten sechs Plätze kämpfen, gewinnen führende Positionen in der ersten Etappe des Rennens und behalten sie bis zum Ende des Rennens.

Schlüsselwörter: Leistung, Taktik, klassischer Stil, Freistil, Gleitgeschwindigkeit, Durchschnittsgeschwindigkeit, optimale Geschwindigkeit, Intervalle der Strecke, Strecke

Introduction

The results of the highest-level ski racing competitions reveal how rapid tension, importance and competitiveness among elite skiers and their mastery of skiing increase in the Winter Olympics and in the World Cup. The art of sports tactics is the ability to find the most suitable physical working capacity for oneself and the most unfavourable one for rivals (Karoblis, 1999). Competitive activity is an athlete's activity during a competition. Competitive activity can be efficient, optimal or inefficient.

The efficiency of competitive activity is an athlete's proximity to the degree of the activity optimal for an individual (Utkin, 1984). The following evaluation criteria are used to assess the optimal competitive activity in cyclic sport branches: speed of movement, economy, rational technique, safety and optimal variants of tactics (Utkin, 1984).

The tactics of cross-country skiers' competitive activity includes a purposeful application of skiing

techniques, taking into account the track relief and gliding conditions. It also includes the optimal distribution of strength and the gliding speed change during a competition. It should also take into account the periods within sport preparation periodization the goal of which is to enable the realization of competitive goals by taking into account also the rivals' fitness and the competition rules (Fomin, 2000; Čepulėnas, 2001). The goal of skiers' competitive activity is to utilize his/her own physical abilities and the cardiorespiratory capacity at their best, as well as his/her technical proficiency and personal traits in the most rational way to obtain the best possible results in the competition (Karpushkin, 1984; Golovatchev, 1985; Čepulėnas, 2001).

Competitive skiers choose the sliding techniques during a race according to the track relief, gliding conditions, gliding speed and fatigue (Gololobov, 1987; Kobzeva et al., 1989; Batalov, 2000; Fomin, 2000). The mastery of the skiers' tactics is closely related to their technical preparedness, as well as their physical and mental fitness (Platonov, 1997; Fomin, 2000). The main factors of skiers' physical working capacity during the competition are as follows: the functional capacity of the cardiovascular and respiratory systems and the production efficiency of mechanical energy in the muscles (Golovkin & Lunkov, 1986; Gololobov, 1987; Batalov, 2000; Ramenskaya, 2000).

The skiers competitive efficiency and gaining-the-distance tactics depend on the organism's adaptation to the physical load in different energy-supply zones (Golovatchev, 1985; Batalov, 2000; Ramenskaya, 2000).

Skiers are categorized into "stayers", "sprinters" and "universals" according to their physiological response to physical load (Kharitonova, Mikhalev, & Chklyayev, 2000).

The skiers' change of speed depends on the terrain engrave, sliding conditions on different stretches of the course, as well as on skier's physical fitness and technical preparedness, equipment and tactics during a competition (Fomin, 1983; 2000; Street, 1992; Bilodeau, Roy, & Boulay, 1994; Gregory, Humphreys, & Street, 1994; Batalov, 2000; Ramenskaya, 2000).

Many scientific works discuss the different ways in which efficiency of skiers' speed changes can either facilitate or hinder accomplishment of desirable results in cyclic endurance sports (Mikhailov et al., 1964; Fomin, 1983; Platonov, 1997; Sirenko, Mishenko, & Dobrovolskij, 1998).

Fomin (2000) has found that in women skiers speed at the beginning of the competition is always higher in the first kilometer than the average competitive speed over the entire distance. Batalov (2000) notes that highly skillful male and female skiers slide at a higher speed during the first 10 km in a 30-km race and at a lower speed during the last 10 km when compared to the average distance speed.

The analysis of skiers' competitive activity tactics is a scientific problem that requires great knowledge of physiology, biochemistry, biomechanics, psychology, metrology and pedagogics (Utkin, 1984; Čepulėnas, 2001; Platonov, 1997; Karoblis, 1997).

The skiers' ability to cover the distance is analyzed according to speed changes in certain separate sections of the course or legs (Fomin, 1983; Skernevičienė & Skernevičius, 1987; Čepulėnas, 1987), and according to lagging behind the leading skier at separate intervals (Mikhailov et al., 1964; Čepulėnas, 1987). It is also important to take into consideration the cross-country skiers' split-time placings at separate stretches of the course, as well as his/her average speed in the different segments of the course (Skernevičienė & Skernevičius, 1987; Fomin 1983, 2000; Batalov, 2000).

Physical and mental fitness, as well as technical preparation among top-level skiers is nearly of the same level. That is why during a competition victory is usually determined by the well chosen tactics of covering the distance. It should be noted that there is a lack of scientific works investigating the peculiarities of the competitive activity tactics of the highly skillful cross-country skiers. Namely, investigation of competitive activity tactics of such skiers may help to understand the competitive activity better and to make the process of sport preparation more effective.

The aim of this paper is to analyze the characteristics of the competitive activity tactics in highly proficient cross-country skiers.

Methods

We have analyzed the long-distance-reach tactics of top-level competitive cross-country skiers (women and men). For this purpose we used the result minutes from the top-level ski racing competitions over the 1992-1998 period listed below:

- XVI. Winter Olympics in Albertville, 1992
- XVII. Winter Olympics in Lillehammer, 1994
- World Skiing Championship in Trondheim, 1994
- XVIII. Winter Olympics in Nagano, 1998

Sport tactics research methods that are presented in scientific publications (Fomin, 1983; Golovatchev, 1985; Platonov, 1987; Sirenko, Mishenko, & Dobrovolskij, 1998) are used in order to analyze the skiers' competitive tactics. Meta-analysis and comparative analysis of the data from the official documents, that is, the minutes (Albertville WO'92, 1992; Lillehammer WO'94, 1994; Nordic World Ski Championships, 1997; Nagano WO'98, 1998) of the ski racing competitions have been executed. According to the data presented in the official documents, we have determined the following characteristic indices of skiers' competitive activity:

- The differences (percentage) between skiers' split times over the first leg of distance (1-15 km) and over the second leg of distance (16-30 km) during a competition over a 30-km distance in total (Table 1).

- Average distance speed (S) of cross-country skiers over the entire distance

$$(S = \frac{\text{distance length (in meters)}}{\text{result (in seconds)}} = \text{m/s});$$

- Average sliding speed (S) of cross-country skiers over separate stretches or legs of the course (Tables 2, 3, 4, 5, 6, 7) was determined according to the skiers' results, fixed at checkpoints,

$$(S = \frac{\text{length of a separate stretch (in meters)}}{\text{time (in seconds) during which the distance is covered}} = \text{m/s});$$

- Placing in certain separate stretches of the course (at checkpoints) (Figures 1, 2, 3, 4, 5).

In total we have analyzed the distance-covering variants of 248 competitive cross-country skiers (178 men and 70 women) during ski racing competitions. The arithmetic means (\bar{x}) and standard deviations (\pm SD) have been calculated.

We have investigated the characteristics of the top-level male and female skiers' competitive activity tactics in the Winter Olympics in Albertville, Lillehammer, Nagano and the World Skiing Championship in Trondheim. The lists of the mentioned competitive cross-country skiers' results have been analyzed. The following indices characterizing the ski racing tactics have been identified: average distance speed, the average sliding speed change over separate legs, and the placings after different stretches of the course. We have investigated the changes of male and female ski racers' results of sliding over the first and the second leg in a 30-km race. After the analysis of the skiers' results in the first and in the second leg of a 30-km race, the indices were divided into the following groups. 1) the indices of the prizewinning

skiers; 2) the first top-ten mean indices (\bar{x}) and 3) mean indices of each of the following top tens.

The tactics were analyzed according to the skiers' speed change at different points over the distance, taking into account lagging behind the leader at different legs of the race. Also, analysis was done of the placings in the various stretches of the course and the comparison was made between the skiers' average speed and their own sliding speed at different legs of the race.

Results

The results are shown in Table 1. The male and female ski racers cover the second part of the distance slower than the first leg in a 30-km race. Only two male skiers among those placed 1st-80th place slid the second leg of the distance faster than the first 15-km in the 30-km race in classical style in the Albertville Winter Olympics. They were placed 63th to 76th. Only three male skiers with 1st-70th placings slid the second leg of the distance faster than the first one in the 30-km race in free style in the Lillehammer Winter Olympics.

The first top-ten male cross-country skiers achieved poorer time results, by 2.97 \pm 2.14%, in the second lap of the free-style 30-km race in Lillehammer. The slide speed deteriorated for the first top-ten female cross-country skiers by 2.79 \pm 1.30% in the second leg of the distance in comparison with the first leg of the 30-km free-style race, as illustrated in Table 1.

The skiers' sliding speed changes over various stretches of the course are presented in Tables 2-7. The tables present the results of the first ten skiers in the races of the Winter Olympics. Skiers slide at different speeds over various stretches of the track. The sliding speed in different legs depends on the track relief and the skiers' tactics, as well as on their physical and mental fitness and technical preparedness. Individual skiers' sliding speed is higher over some intervals of the course than the average distance speed. In some other legs it is lower. The male cross-country competitors slid the legs between 8.6 km and 15 km and 23.6 km to 30 km at the highest speed. The slowest speed intervals were between 1.9 km and 8.6 km and between 15 km and 23.6 km in the 30-km ski race in Albertville, as illustrated in Table 2. The indices presented in Tables 2-7 show that the competitors in lead slide faster over the highest and lowest speed sections of the track than the skiers who were placed worse. The average distance speed of the first top-ten male skiers was $\bar{x} = 5.93 \pm 0.7$ m/s higher than the sliding speed

Table 1. The differences (in percentages, %) in split times of the first and the second leg of a 30-km distance competition

| Classification of skiers according to final standings | Result deterioration (%) in covering the second leg of a 30-km distance (15 km) | | |
|---|---|--------------------------------------|---|
| | Men | | Women |
| | W.O. in Albertville | W.O. in Lillehammer | W.O. in Lillehammer |
| | 30 km classical style ($\bar{X}\pm SD$) | 30 km free style ($\bar{X}\pm SD$) | 30 km classical style ($\bar{X}\pm SD$) |
| 1 | 2.04 | 1.47 | 2.39 |
| 2 | 4.94 | 2.72 | 2.87 |
| 3 | 1.57 | 4.16 | 2.88 |
| 1–10 | 2.90±1.37 | 2.97±2.14 | 2.79±1.30 |
| 11–20 | 2.06±0.88 | 2.59±1.28 | 3.30±0.75 |
| 21–30 | 2.16±1.22 | 2.56±1.45 | 4.21±1.38 |
| 31–40 | 3.11±1.71 | 2.86±2.64 | 3.41±1.52 |
| 41–50 | 3.55±1.45 | 3.44±2.25 | 4.90±2.08 |
| 51–60 | 4.34±1.97 | 4.19±1.62 | – |
| 61–70 | 4.32±2.53 | 3.46±1.59 | – |
| 71–80 | 4.04±2.53 | – | – |

W.O. – Winter Olympics

Table 2. Sliding speed change of the world's best skiers (men) during the 30-km competitions in classical style at the Albertville Winter Olympics

| Placing | Skiers' surname and initial of the first name | Average skiers' speed over certain stretches (m/s) | | | | | Average distance speed (m/s) |
|---------|---|--|--------------|-------------|--------------|--------------|------------------------------|
| | | to 1.9 (km) | 1.9–8.6 (km) | 8.6–15 (km) | 15–23.6 (km) | 23.6–30 (km) | |
| 1 | Ulvang, V. | 6.16 | 5.83 | 6.46 | 5.70 | 6.46 | 6.06 |
| 2 | Daehlie, B. | 6.19 | 5.92 | 6.41 | 5.63 | 6.22 | 6.00 |
| 3 | Langli, T. | 5.99 | 5.73 | 6.36 | 5.58 | 6.47 | 5.97 |
| 4 | Albarelo, M. | 5.99 | 8.83 | 6.39 | 5.56 | 6.28 | 5.95 |
| 5 | Jevne, E. | 6.01 | 5.69 | 6.33 | 5.58 | 6.38 | 5.94 |
| 6 | Majback, C. | 5.94 | 5.74 | 6.28 | 5.60 | 6.34 | 5.93 |
| 7 | Jonsson, N. | 5.91 | 5.70 | 6.26 | 5.46 | 6.25 | 5.86 |
| 8 | Puonsiluoma, J. | 5.71 | 5.63 | 6.30 | 5.51 | 6.25 | 5.85 |
| 9 | Smirnov, V. | 6.13 | 5.77 | 6.19 | 5.50 | 6.04 | 5.85 |
| 10 | Kirvesniemi, H. | 6.04 | 5.72 | 6.21 | 5.44 | 6.20 | 5.84 |
| | \bar{X} | 6.01 | 5.76 | 6.22 | 5.56 | 6.29 | 5.93 |
| | $\pm SD$ | ± 0.14 | ± 0.8 | ± 0.34 | ± 0.08 | ± 0.13 | ± 0.7 |

Table 3. Percentages (%) of male skiers, speed over separate legs compared to the entire distance average speed during the 30-km race in classical style at the Albertville Winter Olympics

| Placing | Skiers' surname and initial of the first name | Sliding speed in percentages compared to the average distance speed (%) | | | |
|---------|---|---|------------|-----------------------------|------------|
| | | Distance interval to 8.6 km | | Distance interval 8.6–15 km | |
| | | I. round | II. round | I. round | II. round |
| 1 | Ulvang, V. | –2.73 | –5.99 | +6.60 | +6.60 |
| 2 | Daehlie, B. | –0.49 | –6.28 | +6.66 | +3.49 |
| 3 | Langli, T. | –3.10 | –6.58 | +6.53 | +8.38 |
| 4 | Albarelo, M. | –1.59 | –6.67 | +7.21 | +5.37 |
| 5 | Jevne, E. | –3.09 | –6.11 | +6.57 | +7.41 |
| 6 | Majback, C. | –2.62 | –5.69 | +5.72 | +6.73 |
| 7 | Jonsson, N. | –2.05 | –6.86 | +6.83 | +6.66 |
| 8 | Puonsiluoma, J. | –3.59 | –5.80 | +7.69 | +6.84 |
| 9 | Smirnov, V. | –0.08 | –5.99 | +5.81 | +3.25 |
| 10 | Kirvesniemi, H. | –1.11 | –7.00 | +6.15 | +5.98 |
| | \bar{X} | –1.71 | –6.41 | +6.50 | +5.68 |
| | $\pm SD$ | ± 1.49 | ± 0.61 | ± 1.00 | ± 1.66 |

Legend: – lower than average distance speed; + higher than average distance speed.

Table 4. Sliding speed change of the world's best female skiers during the 30-km classical style competitions at the Lillehammer Winter Olympics

| Placing | Skiers' surname and initial of the first name | Average skiers' speed over certain stretches (m/s) | | | | | | Average distance speed (m/s) |
|---------|---|--|--------------|-------------|------------|--------------|--------------|------------------------------|
| | | to 1.7 (km) | 1.7–7.8 (km) | 7.8–12 (km) | 12–15 (km) | 15–22.8 (km) | 22.8–30 (km) | |
| 1 | Di Centa, M. | 5.45 | 5.09 | 7.33 | 6.85 | 4.91 | 6.95 | 5.83 |
| 2 | Wold, M. | 5.30 | 5.05 | 7.17 | 6.87 | 4.93 | 7.00 | 5.81 |
| 3 | Kirvesniemi, M-L. | 5.14 | 5,07 | 7.24 | 6.84 | 4.85 | 7.08 | 5.80 |
| 4 | Dybendahl, T. | 5.29 | 4.49 | 7.22 | 6.91 | 4.83 | 6.99 | 5.76 |
| 5 | Egorova, L. | 5.29 | 5,00 | 7.01 | 6.78 | 4.88 | 6.94 | 5.75 |
| 6 | Valbe, E. | 5.19 | 4,93 | 7.26 | 6.84 | 4.85 | 6.98 | 5.74 |
| 7 | Nybraten, I. | 5.30 | 5.02 | 7.18 | 6.79 | 4.78 | 6.90 | 5.73 |
| 8 | Rolig, M. | 5.22 | 4.92 | 7.24 | 6.87 | 4.77 | 6.81 | 5.69 |
| 9 | Nageikina, S. | 5.11 | 4.94 | 6.85 | 6.50 | 4.88 | 6.94 | 5.68 |
| 10 | Moen, A. | 5.09 | 4.87 | 7.21 | 6.91 | 4.71 | 6.91 | 5.66 |
| | \bar{X} | 5.24 | 4.94 | 7.17 | 6.82 | 4.84 | 6.96 | 5.74 |
| | ±SD | ±0.11 | ±0.17 | ±0.14 | ±0.12 | ±0.07 | ±0.07 | ±0.06 |

Table 5. Sliding speed change of the world's best male skiers during the 30-km free style competitions at the Lillehammer Winter Olympics

| Placing | Skiers' surname and initial of the first name | Country | Average speed of skiers, over certain stretches (m/s) | | | | | Average distance speed (m/s) |
|---------|---|---------|---|------------|-----------|------------|------------|------------------------------|
| | | | to 1.7 km | 1.7–7.1 km | 7.1–15 km | 15–22.1 km | 22.1–30 km | |
| 1 | Alsgaard, T. | Norway | 6.538 | 5.940 | 7.993 | 5.952 | 7.928 | 6.902 |
| 2 | Daehlie, B. | Norway | 6.638 | 5.893 | 7.942 | 5.833 | 7.828 | 6.828 |
| 3 | Myllyla, M. | Finland | 6.738 | 5.814 | 7.892 | 5.643 | 7.786 | 6.734 |
| 4 | Botvinov, M. | Russia | 6.190 | 5.729 | 7.894 | 5.688 | 7.796 | 6.691 |
| 5 | De Zolt, M. | Italy | 6.190 | 5.616 | 7.845 | 5.788 | 7.699 | 6.673 |
| 6 | Isometsa, J. | Finland | 6.625 | 5.695 | 7.977 | 5.614 | 7.669 | 6.648 |
| | \bar{X} | | 6.436 | 5.714 | 7.902 | 5.683 | 7.738 | 6.687 |
| | ±SD | | ±0.287 | ±0.082 | ±0.055 | ±0.076 | ±0.063 | ±0.036 |

Table 6. Sliding speed change of the world's best male skiers' during the 30-km classical style competitions at the Nagano Winter Olympics

| Placing | Skiers' surname and initial of the first name | Average skiers' speed over certain stretches (m/s) | | | | Average distance speed (m/s) |
|---------|---|--|-------------|--------------|------------|------------------------------|
| | | to 1.8 km | 1.8–12.3 km | 12.3–23.5 km | 23.5–30 km | |
| 1 | Myllyla, M. | 5.51 | 5.46 | 5.14 | 5.39 | 5.32 |
| 2 | Jevne, E. | 5.29 | 5.33 | 5.03 | 5.45 | 5.24 |
| 3 | Fauner, S. | 5.22 | 5.31 | 5.03 | 5.32 | 5.20 |
| 4 | Isometsae, J. | 5.24 | 5.33 | 4.94 | 5.28 | 5.16 |
| 5 | Valbusa, F. | 5.21 | 5.36 | 4.96 | 5.05 | 5.13 |
| 6 | Kirvesniemi, H. | 5.20 | 5.22 | 4.94 | 5.24 | 5.11 |
| 7 | Albarelo, M. | 5.36 | 5.30 | 4.91 | 5.04 | 5.10 |
| 8 | Di Centa, G. | 5.05 | 5.23 | 4.87 | 5.29 | 5.09 |
| 9 | Legotin, W. | 5.07 | 5.24 | 4.91 | 5.13 | 5.08 |
| 10 | Elofsson, P. | 5.13 | 5.20 | 4.90 | 5.11 | 5.06 |
| | (\bar{X}) | 5.23 | 5.30 | 4.96 | 5.23 | 5.18 |
| | ±SD | ±0.14 | ±0.08 | ±0.08 | ±0.14 | ±0.08 |

Table 7. Sliding speed change of the world's best female skiers during the 30-km free style competitions at the Nagano Winter Olympics

| Placing | Skiers' surname and initial of the first name | Average skiers' speed over certain stretches (m/s) | | | | Average distance speed (m/s) |
|---------|---|--|---------------|----------------|--------------|------------------------------|
| | | to 1.8 (km) | 1.8–11.3 (km) | 11.3–22.3 (km) | 22.3–30 (km) | |
| 1 | Tchepalova, J. | 5.86 | 6.25 | 5.91 | 6.25 | 6.10 |
| 2 | Belmondo, S. | 5.79 | 6.30 | 5.91 | 6.17 | 6.08 |
| 3 | Lazutina, L. | 5.73 | 6.17 | 5.82 | 6.16 | 6.01 |
| 4 | Nilsen, E. | 5.70 | 6.12 | 5.72 | 6.05 | 5.92 |
| 5 | Valbe, E. | 5.72 | 5.13 | 5.72 | 5.91 | 5.89 |
| 6 | Theurl, M. | 5.53 | 6.03 | 5.70 | 6.10 | 5.89 |
| 7 | Albrecht, B. | 5.63 | 5.99 | 5.70 | 6.02 | 5.87 |
| 8 | Taranenko, I. | 5.80 | 6.08 | 5.65 | 5.92 | 5.86 |
| 9 | Mikkelplass, M. | 5.46 | 6.00 | 5.68 | 6.00 | 5.84 |
| 10 | Paruzzi, G. | 5.60 | 6.03 | 5.62 | 5.88 | 5.81 |
| | (\bar{X}) | 5.68 | 6.10 | 5.74 | 6.04 | 5.84 |
| | \pm SD | \pm 0.13 | \pm 0.33 | \pm 0.10 | \pm 0.12 | \pm 0.10 |

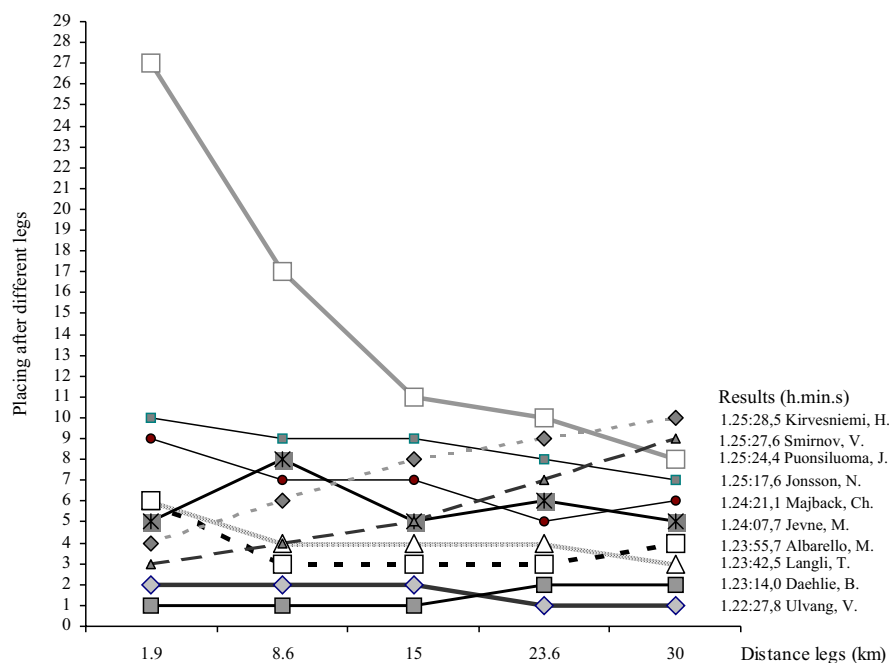


Figure 1. Tactics of the world's best male skiers in the 30-km race in classical style at the Albertville Winter Olympics.

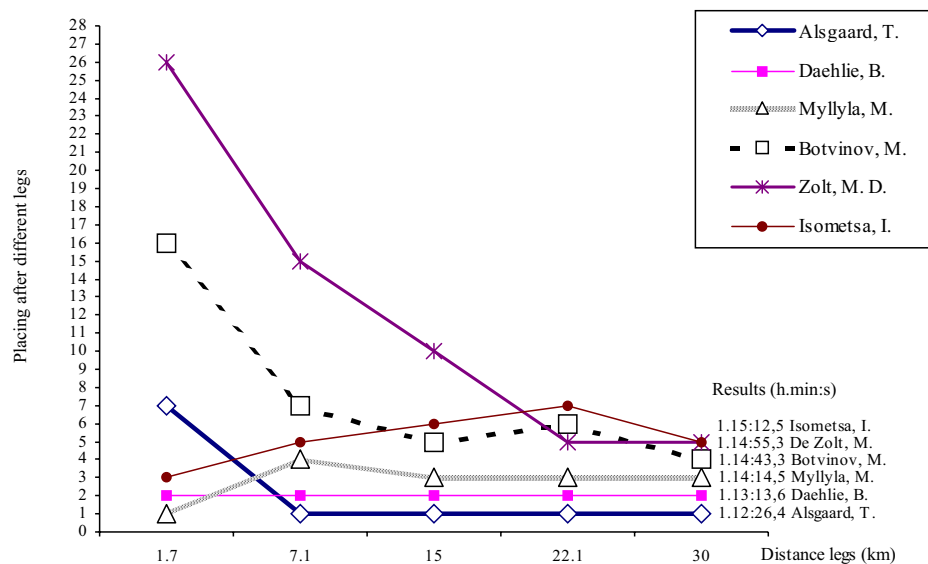


Figure 2. Tactics of the world's best male skiers in the 30-km free-style race at the Lillehammer Winter Olympics.

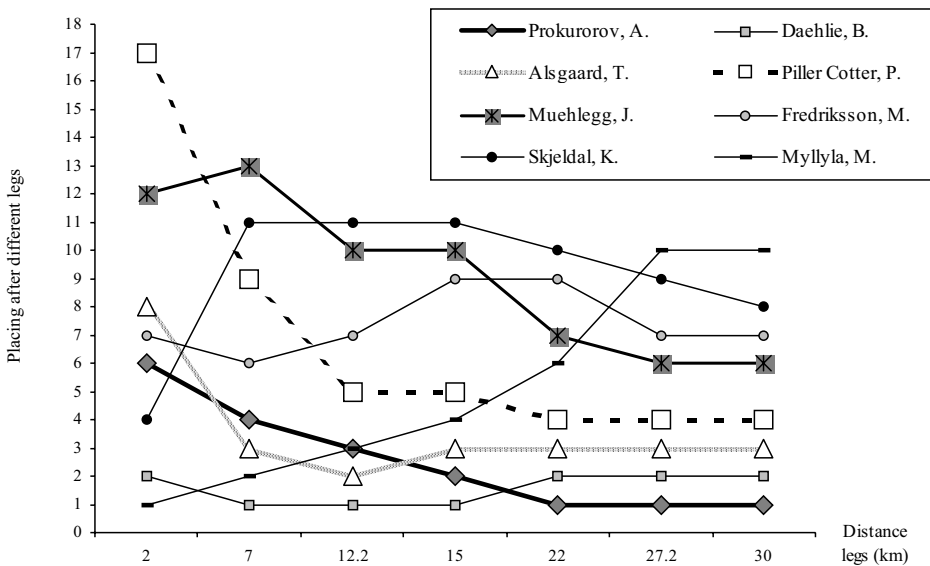


Figure 3. Changes of the placings in the first top ten male skiers skiing over the separate legs of the 30-km free-style race at the 1997 World Skiing Championship in Trondheim.

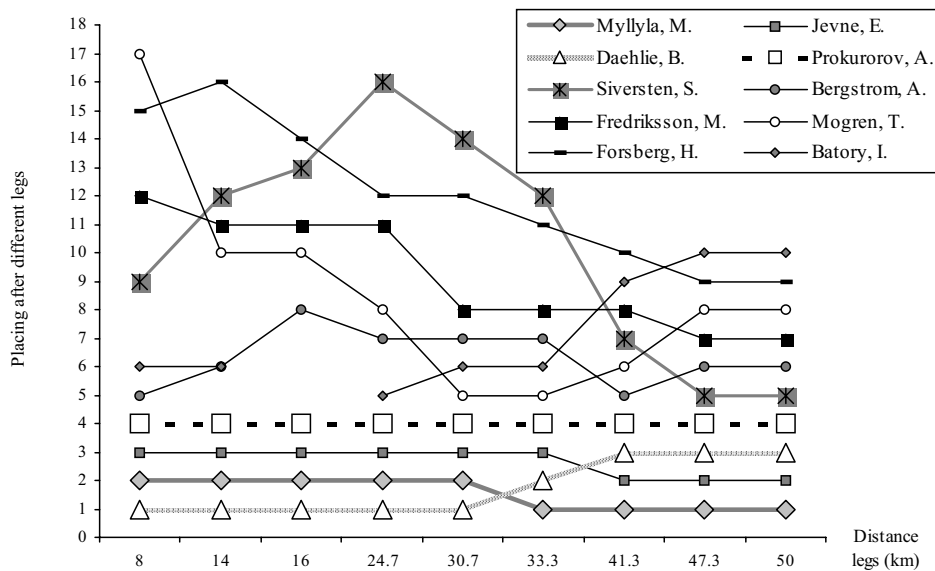


Figure 4. Changes of the placings in the first top ten male skiers over the separate legs of the 50-km classical-style race at the 1997 World Skiing Championship in Trondheim.

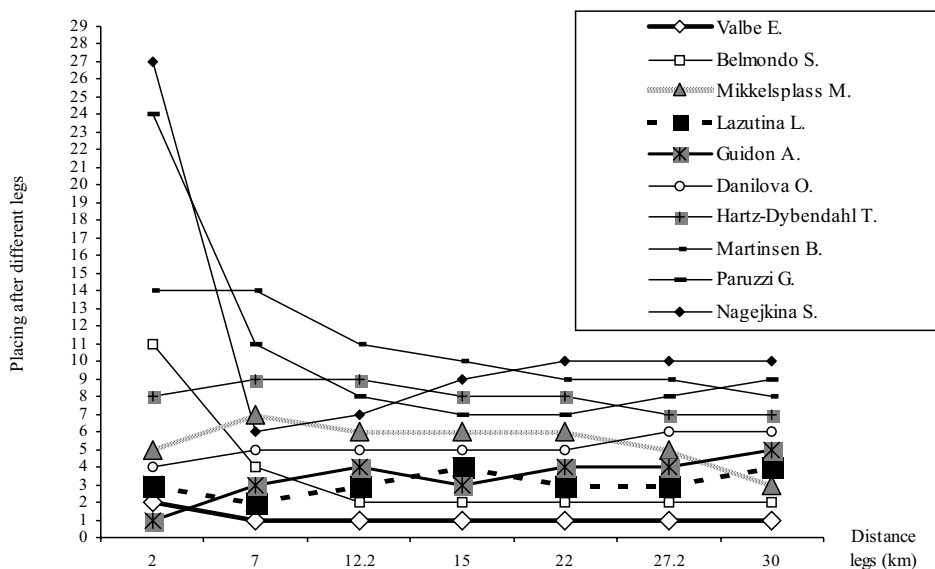


Figure 5. Changes of the placings in the first top ten, female skiers skiing over the separate legs of the 30-km classical-style race at the World Skiing Championship in 1997 in Trondheim.

over the lowest speed course interval, but lower than the sliding speed in the track interval of the highest speed in the 30-km men's race, classical style, at the Albertville Winter Olympics.

When skiers cover two 15-kilometer laps in the 30-km race, it is possible to determine how the skiers' speed changes over those stretches of track during a competition (Table 3). The first top-ten skiers' average sliding speed (\bar{X}) in the stretches of track from the start to 8.6 km in the first leg was $1.71 \pm 1.49\%$ lower than the average distance speed. In the second leg their sliding speed over the same stretch was $6.41 \pm 0.61\%$ lower than the average distance speed gained (Table 3) in the 30-km race in classical style at the Albertville Winter Olympics. The sliding speed of the first top-ten skiers in the stretch of course from 8.6 km to 15 km in the first leg was $6.50 \pm 1.00\%$ on average. In the second leg the sliding speed was $5.68 \pm 1.66\%$ higher than the average distance speed (Table 3).

Di Centa, M., the champion in the 30-km women's race in the Lillehammer Winter Olympics, slid faster than her rivals over the first lap. She was able to retain an advantage until the finish and finally she won the competition, in spite of the fact that in the last stretch of the course, from 22.8 km to 30 km, her sliding speed was insignificantly lower in comparison to the second and the third placed prizewinners in the 30-km women's race in classical style at the Lillehammer Winter Olympics (Table 4). The champion's average distance speed was 5.83 m/s. The course interval of the highest speed was the one between 7.8–12 km – 7.33 m/s (12.97% higher than her average distance speed) in the 30-km women's race in classical style (Table 4). Over the lowest-speed track interval (15–22.8 km) the sliding speed was 4.91 m/s (11.87% lower than the individual average distance speed).

The individual sliding speeds of the male ski racers over various stretches of the course in the 30-km race in free style in the Lillehammer Winter Olympics are presented in Table 5.

The individual sliding speeds over the highest-speed track interval (7.1–15 km) of the skiers who took the 1st through the 6th place in the race were 7.84–7.99 m/s. However, in sliding over the same track interval in the second leg, the sliding speeds were lower (7.67–7.93 m/s).

The skiers' sliding-speed-change indices in the 30-km race in the Nagano Winter Olympics are presented in Tables 6 and 7. The male champion in the 30-km men's race slid faster in the classical style than the other skiers over all the stretches of the track up to 23.5 km and gained sufficient time

advantage over his rivals. The champion's sliding speed in the last stretch of the course, from 23.5 to 30 km, was lower than his rivals speed who was second. However, the champion's advantage gained was enough to win the race (Table 6).

The average distance speed of top-ten female skiers was 5.84 m/s (Table 7). Over the highest-speed track interval (1.8–11.3 km) they slid by speed of 6.10 m/s (10.44% higher than the average distance speed) in the 30-km women's race in free style. Women's sliding speed in the stretches of track from the start to 1.8 km and from 11.3 km to 22.3 km was correspondingly 10.28% and 10.17% lower than their average distance speed. The champion of this race, J. Tchepalova, and Silver Medal winner, S. Belmondo, slid faster over all the stretches of track than their rivals (Table 7). The champion slid faster than her main rival, S. Belmondo, over the stretch of track from 22.3 km to 30 km and won the race.

The skiers who were placed between the 1st and 10th place in separate stretches of track during the observed competitions are presented in figures 1–5. The presented indices characterize the skiers' covering-the-distance tactics during competition. The indices presented in figures 1, 2 and 4 show that the prizewinners (1st to 3rd places) took the leading position in the first kilometres of the race and were able to retain their advantage over their rivals up to the finish. The indices presented in figures 3 and 4 point to the fact that the top-class competitive cross-country skier B. Daehlie, who won the silver and bronze medals, slid faster over the first leg of the track than his rivals and was the leader, but lost in the second leg of the track. The characteristic feature of the skier's tactics in this competition is the high sliding speed and the maximum use of his physical capacity over the first leg of the track. Although this skier slid slower in the second leg of the course and was not able to keep his advantage over his closest rivals, his results were, nevertheless, very good. He won silver and bronze.

Figure 5 shows that the skier E. Valbe, who became a champion, started the distance with a high speed and after 7 km took the leading position and won the race. The skier S. Belmondo, who won the silver medal, started the distance at a lower speed in comparison with the others, but increased it progressively. Having reached the 12.2 km, she was in the second place and slid the whole distance in the second position without any changes. Bronze medal winner, M. Mikkelsplass, used strong finishing tactics in this race, i.e. over the stretch of track from 27.2–30 km she progressed from the fifth place to the third.

Discussion and conclusions

The investigation results (Tables 4-7, Figures 1-5) reveal that top-level competitive cross-country skiers start with a high, but individually optimal speed. During the first kilometers they often take the leading position and keep it over the whole distance to the finish. Race winners, prize winners and the first ten skiers gain speed over their rivals during covering the first leg of the course and very often they keep their advantage until the finish. Skiers who used these tactics were placed high over separate stretches of the track. This kind of tactics is used by very highly skillful skiers who are in excellent form. They are dominant leaders of the competition.

Fomin (2000) has defined the characteristics of the distance gaining tactics of the ski masters which determine competitive efficiency:

- 1) high sliding speed at the beginning of the race – the starting speed is 4-6% higher than the average distance speed;
- 2) female skiers' speed change over the distance that reaches 7-9%;
- 3) skiers' attempts to increase the sliding speed while approaching the finish in the 30-km race, when there are 1,200-2,500 meters left.

Some investigations (Fomin, 1983; Skernevičienė & Skernevičius, 1987) show that skiers' finishing and starting speeds have a close connection with the average distance speed. Skiers whose average distance speed is higher start and finish at a higher speed.

The indices of the presented investigation (Tables 2, 3, 4, 5, 6, 7) show that skiers whose average distance speed is higher, slide at a higher speed, both over the high- and low-speed intervals of the course, than the skiers whose average distance speed is lower. Their distribution of strength while covering the long distances is more economical and a better result is achieved when a movement speed deviation from an average speed over separate legs of the distance does not exceed 3-4% of the average distance speed (Mikhailov et al., 1964; Sirenko, Mishenko, & Dobrovolskij, 1998).

Results shown in Table 1 reveal that skiers' sliding speed, while covering the second 15-km leg of the 30-km race, decreases differently and individually. The champion O. Ulvang covered the second leg of the track with a 2.04% worse time result than the first leg in the 30-km race in classical style at the Albertville Winter Olympics. B. Daehlie, the silver medal winner, covered the second leg of the track with a 4.94% poorer result than the first leg.

Skiers who won 40th–80th places in the 30-km race achieved a worse result while covering the second leg of the track in comparison to those who won 1st–30th places (Table 1).

Cross-country skiers' sliding speed decreases over the same stretches of the course while covering the second leg. Individual speed change depends on the chosen tactics in comparison to the average distance speed. The obtained indices in this (Tables 3–7 and Figures 1-5) and previous studies show that skiers who do not enter the top ten during the first kilometers of the distance are not able to win prizewinning places in the highest-level skiing competitions (Čepulėnas, 1987; 2001).

It can be concluded that skiers' competitive tactics, beside other factors, are determined by adaptation of their organism, to different track relief peculiarities. These tactics also depend on the capacity of the organism as well as on the individual's aerobic and anaerobic energy production (Batalov, 2001; Kharitonova, Mikhalev, & Chklyayev, 2000; Rameskaya, 2000).

The presented study has highlighted the following tendencies in skiers' competitive tactics:

1. Skiers' placements over separate stretches of the course differ slightly from the final standings in the race.
2. Skiers' standings over separate stretches of the track change and the final standings in the race are higher than those won over the first leg of the distance.
3. Skiers' placings in separate stretches of the track are higher than the standings in the race; they lose to their rivals during the second leg of the track and at the finish.
4. The following tactical variants of the highly-proficient-skiers competitive activities have been determined:
 - Some skiers pursue the whole distance almost equally and at individual optimal high speed, trying to keep the equal work intensity over the distance.
 - Some skiers lose insignificantly to rivals at the beginning, but in the middle of the race they catch up with them, exceed the speed and win better places than the placings in the separate intervals of the first leg of the track.
 - Some start the distance coverage at high speed; skiers cover the first kilometers in a leading group. It may happen that some leaders win against the main rivals, but in the middle of the race and at the finish they are not always able to keep the gained superiority. Nevertheless, they win high

places, but lower than that at the beginning of the race.

- In some tactical variants the beginning and the middle of the course are gained with high optimal speed, but skiers try to save some energy for the finish. They also try to beat the rivals in the second leg by powerful gliding

the last kilometers - these are the strong finishing tactics.

- Skiers whose average distance speed is higher, glide faster in the slowest and in the fastest speed intervals of the track, and vice versa, the skiers whose average distance speed is lower, glide slower in them.

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TAKTIKA VRHUNSKIH SKIJAŠA TRKAČA

Sažetak

Uvod

Umijeće sportske taktike jest sposobnost da sportaš pronađe radno opterećenje koje će njemu najviše odgovarati, a istodobno će biti najnepovoljnije za suparnike. Natjecateljska aktivnost je sportaševa aktivnost tijekom natjecanja. Može biti učinkovita, optimalna i neučinkovita. Učinkovitost natjecateljske aktivnosti definira se kao stupanja do kojega se sportaš uspio približiti razini opterećenja koja je za njega idealna. Natjecateljska aktivnost u cikličkim sportovima procjenjuje se sljedećim kriterijima: brzina kretanja, ekonomičnost izvedbe, racionalna tehnika, sigurnost i optimalna taktička varijanta.

Moglo bi se reći da su vrhunski skijaši trkači na približnoj istoj razini fizičke, tehničke i psihičke pripremljenosti. Stoga sportski uspjeh ovisi o dobro odabranoj taktici za svladavanje pruge. Nema puno istraživanja o obilježjima taktike vrhunskih skijaša, a ona bi pomogla da se bolje razumije natjecateljska aktivnost i da se unaprijedi process sportske pripreme.

Metode

U radu su analizirane taktike koje su vrhunski skijaši trkači na duge pruge (žena i muškaraca) primijenili u razdoblju od 1992. – 1998. godine na sljedećim natjecanjima: XVI. zimske olimpijske igre, održane u Albertvilleu 1992. godine, XVII. zimske olimpijske igre, održane u Lillehammeru 1994, Svjetsko skijaško prvenstvo, održano u Trondheimu 1994. godine, i XVIII. zimske olimpijske igre, održane u Naganu 1998 godine. Korišteni su podaci objavljeni u službenim izvješćima s natjecanja. Iz službenih podataka izračunato je sljedeće:

- razlika (u postocima) između rezultata (vremena) koje su skijaši trkači postigli u prvom dijelu utrke (1–15 km) i u drugom dijelu utrke (16–30 km) na 30 km (tablica 1).
- ukupna prosječna brzina skijaša trkača (S) of ski racers in the whole distance,
- prosječna brzina skijaša trkača (S) na pojedinim dionicama utrke (tablice 2, 3, 4, 5, 6, 7) ustanovljena je prema prolaznim vremenima,
- poredak (trenutačni) na nadzornim postajama (prikazi 1, 2, 3, 4, 5).

Analizirane su taktike 248 skijaša trkača (178 muškaraca i 70 žena) tijekom velikih svjetskih natjecanja.

Nakon što su analizirane promjene u brzini trčanja u prvom i u drugom dijelu utrke, podaci su podijeljeni u tri skupine: 1) podaci o dobitnicima medalja; 2) prosječni podaci za deset prvoplasiranih skijaša trkača i 3) prosječni podaci za svakih idućih deset skijaša trkača (prema poretku na kraju utrke).

Obilježja taktike pojedinih skijaša ili skupina skijaša (po deset) utvrđena su na temelju promjena u brzini skijanja na pojedinim dionicama pruge, vremenskom zaostatku za vodećima na pojedinim dionicama, trenutačnom poretku na nadzornim točkama te iz usporedba ukupne prosječne brzine pojedinoga skijaša s njegovim/njezinim brzinama skijanja na pojedinim dionicama pruge.

Rezultati

Rezultati su prikazani u tablicama 1-7 i u prikazima 1-5. Svi su skijaši i skijašice bili sporiji u drugom dijelu staze (tablica 1), premda su te razlike izrazito individualne. "Najsporije dionice" bile su one između 1,9 km i 8,6 km te između 15 km and 23,6 km (tablice 2-7).

Rasprava i zaključci

Rezultati su pokazali da najkvalitetniji skijaši trkači (osvajajući medalja) započinju utrku velikom, ali optimalnom i individualno prilagođenom brzinom. Tijekom prvih kilometara zauzimaju vodeće pozicije i uspijevaju ih očuvati sve do konca utrke. Ti su trkači zauzimali prva mjesta i u trenutačnom poretku. Takvu taktiku koriste najkvalitetniji trkači koji su izvrsno pripremljeni.

Također je vidljivo (tablice 2, 3, 4, 5, 6 i 7) da skijaši s višom ukupnom prosječnom brzinom prelaze i najsporije i najbrže dionice brže od skijaša s nižom ukupnom prosječnom brzinom. Distribucija snage je u njih ekonomičnija, a bolji rezultati postižu se ako se skijaševa brzina na pojedinim dionicama ne razlikuje od njegove/njezine ukupne prosječne brzine za više od 3-4%. Brzina skijanja je također individualno opadala na svakoj dionici koju je skijaš prelazio po drugi put. Rezultati ovog istraživanja (tablice 3–7 i prikazi 1-5), ali i nekih ranijih istraživanja, pokazali su da skijaši koji se ne uvrste među vodeće tijekom prvih kilo-

metara utrke ne uspijevaju osvojiti medalje na najvećim natjecanjima.

Prepoznatljiva su sljedeće tendencije i varijacije obilježja natjecateljske taktike kvalitetnih skijaša trkača:

1. trenutačni plasmani (na nadzornim točkama) razlikuju se vrlo malo od konačnog poretka;
2. trenutačni plasmani se mijenjaju, a primjetna je tendencija da su najkvalitetniji skijaši bili u konačnom poretku bolje plasirani nego na polovini utrke;
3. neki skijaši su bili bolje trenutačno plasirani nego u konačnom poretku; gubili bi svoje pozicije u drugom dijelu utrke ili u samoj konačnici;
4. ustanovljene su taktičke inačice zamjetne u skijanju najkvalitetnijih skijaša trkača:
 - čitava staza prelazi se ujednačenom, individualno prilagođenom brzinom;

skijaši pokušavaju održati jednolik intenzitet rada;

- drugi skijaši neznatno zaostanu na početku utrke, ali u sredini i na kraju utrke uspiju dostići, čak i preći svoje suparnike povećanjem brzine te se konačno plasirati bolje nego u prvom dijelu utrke;
- neki počinju utrku velikom brzinom i na prvim kilometrima su u vodećoj skupini. No, mnogi ne izdrže tempo, pa u sredini ili na kraju utrke popuste ne mogavši sačuvati prednost, pa ih izravni suparnici prestignu; ipak, uspijevaju osvojiti dobra mjesta, ali slabija od trenutačnih plasmana u prvom dijelu utrke;
- taktika snažnog finiša odlikuje se relativno velikom, ali optimalnom brzinom skijanja na početku i u sredini utrke, ali skijaši čuvaju energiju za snažnu završnicu.