

CHARACTERISTICS OF FUNCTIONAL TENSION OF QUALIFIED SKIERS WHEN PASSING RISES OF DIFFERENT DIFFICULTY

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Abstract. *Purpose:* studying of main functional changes in organism of qualified female skiers when passing rises of different difficulty. *Materials:* 12 female skiers of combined team of Ukraine of 21-34 years' age were tested. Pedagogic observation included: speed metering (system of GPS- navigation), pulse metering (telemetric register of heart beats rate Polar RS800). In process of ski track passing we registered content of exhaled air (radio-telemetric gas-analytic complex MetaMax 3B, Cortex). Sportswomen fulfilled control passing of competition 6 km distance (2 circles, 3 km each) in classic style on ski rollers. Ski track was determined by coach. In the course of track's passing we registered indicators of speed and track profile with discreteness 1 sec. Assessment of special workability and realization of functional potentials was determined by characteristics of external breathing at the end of each rise. *Results:* it was found that the highest correlation belonged to the following indicators: frequency of breathing ($r = 0.38$); oxygen consumption ($r = 0.29$); ventilation equivalent by O_2 ($r = 0.68$). We detected high interconnection between length of distance and ventilation equivalent by CO_2 ($r = 0.61$). It was determined that factors of organism's anaerobic efficiency change according to relief of track. They increase on rises and reduce on descends. With it increase on long rises is much higher than on middle size rises. *Conclusions:* effectiveness of different difficulty rises' overcoming depends on potentials of anaerobic mechanisms and their realization that, to certain extent, influence on sport efficiency.

Key words: skiing, functional fitness, relief, ski track, aerobic, anaerobic.

Introduction

As on to day, in skiing, there have been observed steady growth of contest in parallel with complicating of competitions' conditions that requires seeking of new reserves of elite sportsmen's efficiency. That is why problem of skiers' functional fitness and its realization in complex competitions' conditions has still been insufficiently studied. For example, it was determined that realization of sportsmen's individual potentials in skiing is conditioned by special conditions of competition functioning and depends on level of sportsmen's functional fitness. It shall be considered when planning training means and methods in skiing [1, 6, 4].

Leading specialists in skiing, such as G.G. Khokhlov [18], O.I. Kamayev [4], V.V. Mulyk [12], T.I. Ramenska [16] et al. note that for regular and purposeful functional training for highest sport achievements skiers racers shall consider metrical and time parameters of competition load on different components of tracks' relieves.

With it in ski racings just rises are the elements of track where even insignificant advantage can significantly improve competition result. In opinion of authors [13, 14, 16, 18] total length of rises reaches 50% of distance and sportsmen spend 43-51% of all racing time for their passing.

Rises are the most difficult and important parts in ski racings. They require increased functional, will and tactic fitness of sportsmen. Depending on correlation of rises of different length and their steepness, flat parts and descends, tracks are classified as flat ones, moderately rough, rough and strongly rough. With increasing of sport qualification level, skiers pass to more and more difficult, by relief, tracks. Characterizing parameters of tracks' difficulty, most of authors [1, 2, 4, 6] quite correctly relate to them steepness and length of rises, sum of height difference, difficulty and harmony.

Depending on energetic supply of skiers' organisms all rises on tracks can be conventionally divided into three groups: short (time of passing up to 18 sec.; work is fulfilled mainly at the account of anaerobic a-lactate processes); middle (time of passing – up to 60 sec.; anaerobic glycolytic processes prevail); long (time of passing – up to 150 sec.; anaerobic glycolytic productivity reaches maximum, but role of aerobic energy sources increases) [7]. With it total time for passing of these rises is different, though aerobic metabolism at competitions in ski racings is main energy source [6]. On rises of certain length and steepness role of anaerobic mechanisms manifests to the fullest and they to certain extent determine competition result of skier-racer.

Analysis of special literature and practical experience witnesses that up to the present time there have been nearly no scientifically substantiated recommendations on passing of different parts of tracks. Besides there is no requirements to functional fitness of skiers for passing of rises of different difficulty.

Purpose, tasks of the work, material and methods

The purpose of the research is to determine main model characteristics of elite female skiers' functional fitness when they pass rises of different difficulty.

Materials and methods: in our work we used the following methods: theoretical analysis and generalization of data of special scientific-methodic literature. Pedagogic observation included: speed metering (system of GPS-navigation), pulse metering (telemetric register of heart beats rate Polar RS800 - Finland). Besides, in process of ski track

passing we registered content of exhaled air and spirometry parameters (radio-telemetric gas-analytic complex MetaMax 3B, Cortex, Germany).

Testing of sportswomen's functional potentials in simulated conditions of passing of competition distance was carried out on training-sport base "Tysovets" (Lvivska region) at the beginning and at the end of training period. In the research 12 sportswomen of 21-34 years' age participated. All they were masters of sports and international masters of sports and members of National combined ski racing team of Ukraine.

In the course of the researches sportswomen fulfilled control passing of competition 6 km distance (2 circles, 3 km each) in classic style on ski rollers. The track was determined by coach. In the course of track's passing we registered indicators of speed and track profile with discreteness 1 sec. Assessment of special workability and realization of functional potentials was determined by characteristics of external breathing at the end of each rise.

Results of the research

The distance included 5 rises in every circle and had the following characteristics:

- total length of rises was 47% of distance length;
- maximal rise was 30 meters;
- sum of height differences – 148 m;
- steepness: 1st rise – 2.03%; 2nd rise - 5.68%; 3rd rise – 7.33%; 4th rise - 6.40%; 5th rise – 1.95%;
- mean steepness of rises – 4.79%.
- length: 1st rise - 558 m; 2nd rise - 193 m; 3rd rise - 337 m; 4th rise -184 m; 5th rise - 272 m.

Total length of descends was 32.7% of distance length.

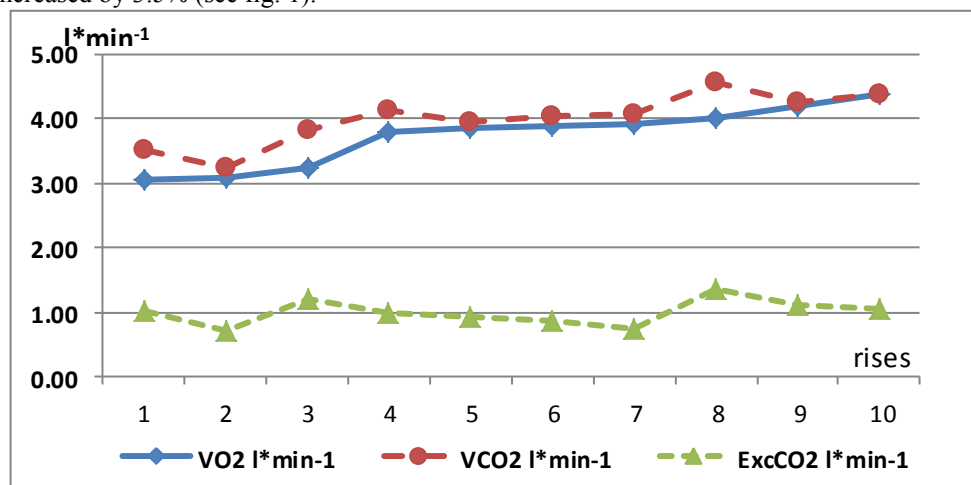
Correlation of total sum of all rises' length to total sum of all descends' length determines harmony of the track. It was 1.41 conv.un. The value, more than 1 conv.un., means, that in such track long rises combine with short descends. At every kilometer of competition distance female skiers ascended in average by 25 meters (difficulty of track).

Basing on the received measurements of track relief we found that the track corresponds to weakly rough profile. We also determined that mean speed on rises was within 3.55 – 5.19 meters per sec.; on descends – from 7.76 to 15.5 m.p.sec. Speed of international competitions' winners is 6.0-6.4 m.p.sec.

For determination of the most important track's influences on sportsmen's functional fitness we carried out correlation analysis. We have found that the highest correlation belonged to the following indicators: frequency of breathing ($r = 0.38$); oxygen consumption ($r = 0.29$); ventilation equivalent by O_2 ($r = 0.68$). We detected high interconnection between length of distance and ventilation equivalent by CO_2 ($r=0.61$).

For sportswomen the following maximal values of indicators, which characterize realization of functional potential in simulated conditions of competition distance passing, are characteristic: breathing volume per minute - 140.5 ± 17.4 $l \cdot min^{-1}$; oxygen consumption 3.8 ± 0.3 $l \cdot min^{-1}$ (66.8 ± 5.1 $l \cdot min^{-1} \cdot kg^{-1}$); release of carbon dioxide – 4.2 ± 0.3 $l \cdot min^{-1}$; breathing coefficient 1.4 ± 0.1 conv.un.; heart beats rate - 195.3 ± 5.3 b.p.m; oxygen pulse – 24.08 ± 8.7 $ml \cdot s^{-1}$. Analysis of the research's results witness that factors of skiers racers' anaerobic efficiency change according to relief of the track. They increase on rises and reduce on descends. With it increase on long rises is much higher than on middle size rises. Results of the researches are given in tables 1 and 2.

In assessment of sportswomen's functional potentials at the beginning and at the end of training period we determined maximal power of their work, which was 383.7 ± 3.2 W and 402.6 ± 7.5 W; so oxygen consumption on different rises increased by 2.8%. Release of carbon dioxide (CO_2) and its excess (Exc CO_2) on short rises reduced by 1.8% and on main rises it increased by 3.5% (see fig. 1).



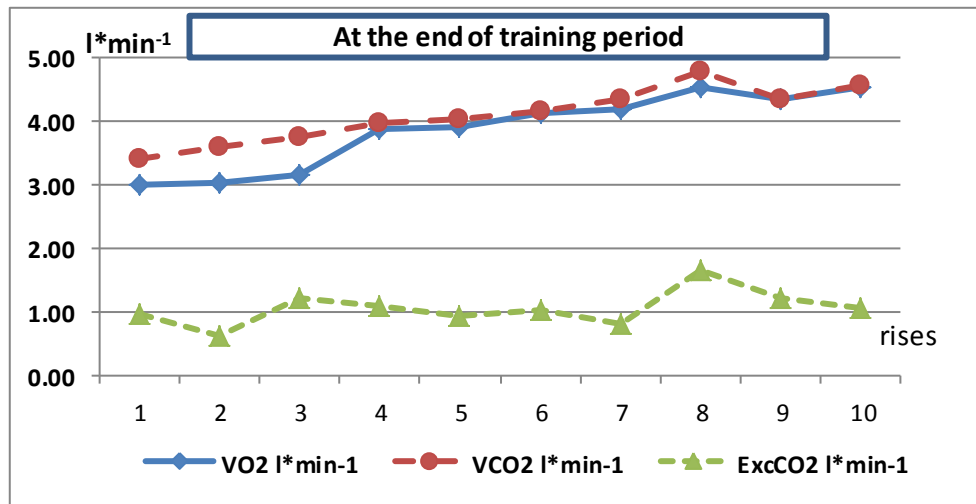


Fig.1. Dynamic of changes of oxygen consumption indicators (VO_2), release of CO_2 (VCO_2) and its excess ($ExcCO_2$) in elite female skiers on rises of different difficulty at the beginning and at the end of training period.

Lung ventilation reached 92% of maximum. Heart beats rate (HBR) reached to maximal values (especially at the end of training period). The received data witness that passing of main and short rises with maximal speed results in significant increase of functioning of anaerobic and aerobic mechanisms of metabolism in sportswomen's organisms. On the base of the received data we determined model characteristics of elite female skiers' functional fitness when passing rises of different difficulty (see fig.2.)

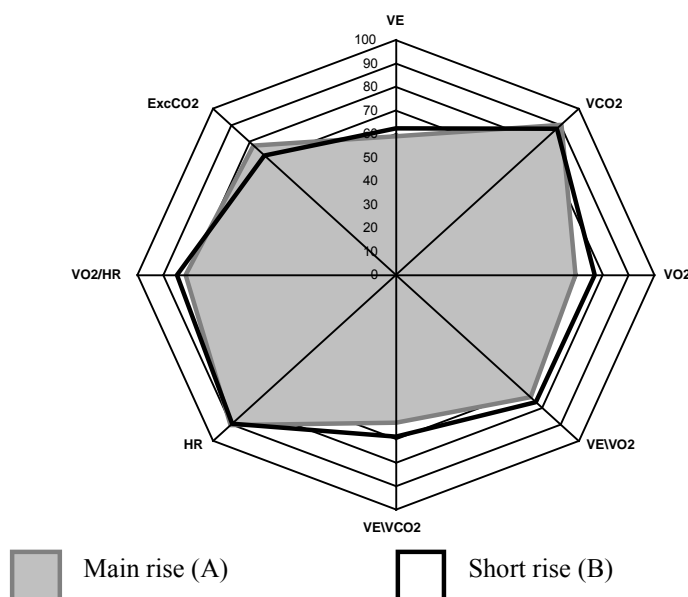


Fig.2. Model functional characteristics of female skiers on rises of different difficulty (% from maximal value)

The most intensive energy supply of organism was on main rises. With it contribution of anaerobic mechanisms increased. It was witnessed by higher values of carbon dioxide release (VCO_2) as well as its excess ($ExcCO_2$). On short rises oxygen consumption was the highest.

Table 1.
Indicators of female skiers' functional fitness in conditions simulating passing of competition distance at the beginning of training period

Part of distance and time of measurement	Speed	Angle	Body mass	P	VT	f	V _E	V _{O2}	V _{CO2}	V _{O2}	RQ	V _E \ V _{O2}	V _E \ V _{CO2}	HR	V _{O2} /HR	ExcCO ₂	
	Km.p.hr	%	kg	W	l	l*min ⁻¹	l*min ⁻¹	l*min ⁻¹	l*min ⁻¹	ml/min/kg	Conv.un	Conv.un	Conv.un.	b/p/m ⁻¹	ml*beats ⁻¹	l*min ⁻¹	
1 rise	01:37,00	17.19	2.03	56.1	235.9	1.7	49.8	109.7	3.05	3.51	54.4	1.2	35.9	31.2	178.3	17.1	1.03
2 rise	03:03,00	15.30	5.68	56.1	285.5	1.7	48.3	106.1	3.08	3.24	54.8	1.1	34.5	32.8	183.0	16.8	0.70
3 rise	00:04:49	13.68	7.33	56.1	286.1	1.6	54.9	118.5	3.25	3.83	58.0	1.2	36.4	30.9	186.8	17.4	1.20
4 rise	05:48,00	19.08	6.40	56.1	374.8	1.7	49.1	110.8	3.80	4.14	67.7	1.1	29.1	26.7	181.0	21.0	0.99
5 rise	06:56,00	18.72	1.95	56.1	257.0	1.6	56.5	114.3	3.85	3.95	68.6	1.0	29.7	28.9	183.0	21.0	0.93
6 rise	00:10:10	17.10	2.43	56.1	245.2	1.7	54.9	114.0	3.90	4.05	69.5	1.0	29.2	28.1	188.8	20.7	0.87
7 rise	11:18,00	14.58	6.18	56.1	282.0	1.5	58.5	118.8	3.91	4.08	69.7	1.0	30.4	29.1	173.8	22.5	0.74
8 rise	13:07,00	13.32	7.70	56.1	284.7	1.5	59.3	119.5	4.00	4.58	71.3	1.1	29.9	26.1	192.8	20.8	1.36
9 rise	13:59,00	17.73	6.30	56.1	347.5	1.5	58.4	116.9	4.19	4.25	74.7	1.0	27.9	27.5	187.5	22.3	1.10
10 rise	15:12,00	19.26	1.75	56.1	260.0	1.5	56.2	109.5	4.39	4.40	78.2	1.0	24.9	24.9	188.3	23.3	1.03

Table 2.
Indicators of female skiers' functional fitness in conditions simulating passing of competition distance at the end of training period

Part of distance and time of measurement	Speed	Angle	Body mass	P	V _T	f	V _E	V _{O2}	V _{CO2}	V _{O2}	RQ	V _E \ V _{O2}	V _E \ V _{CO2}	HR	V _{O2} /HR	ExcCO ₂	
	Km.p.hr	%	kg	W	l	l*min ⁻¹	l*min ⁻¹	l*min ⁻¹	l*min ⁻¹	ml/min/kg	Conv.un	Conv.un	Conv.un.	b/p/m ⁻¹	ml*beats ⁻¹	l*min ⁻¹	
1 rise	01:51,00	17.28	1.60	55.0	224.9	1.7	48.5	106.3	3.01	3.41	54.7	1.1	35.3	31.2	179.0	16.8	0.96
2 rise	03:06,00	14.94	5.20	55.0	263.9	1.6	47.8	101.3	3.02	3.61	54.9	1.2	33.5	28.1	183.3	16.5	0.61
3 rise	05:02,00	13.68	7.20	55.0	277.7	1.5	57.3	116.9	3.16	3.77	57.5	1.2	37.0	31.0	187.8	16.8	1.21
4 rise	05:57,00	18.45	5.70	55.0	338.8	1.6	50.9	108.9	3.89	3.98	70.7	1.0	28.0	27.4	181.5	21.4	1.07
5 rise	07:09,00	18.27	1.40	55.0	232.2	1.5	59.5	116.3	3.90	4.05	70.9	1.0	29.8	28.7	183.3	21.3	0.94
6 rise	10:23,00	17.19	3.00	55.0	254.2	1.7	54.3	114.7	4.12	4.15	74.9	1.0	27.8	27.6	189.3	21.8	1.02
7 rise	11:34,00	14.67	7.00	55.0	293.5	1.5	58.8	114.9	4.20	4.34	76.4	1.0	27.4	26.5	190.5	22.0	0.79
8 rise	13:23,00	13.41	7.20	55.0	272.4	1.5	59.7	118.5	4.54	4.78	82.5	1.1	26.1	24.8	193.0	23.5	1.64
9 rise	14:24,00	18.36	6.90	55.0	368.7	1.5	56.4	113.5	4.35	4.36	79.1	1.0	26.1	26.0	187.5	23.2	1.21
10 rise	15:29,00	19.44	2.70	55.0	280.6	1.4	57.8	107.2	4.53	4.58	82.4	1.0	23.7	23.4	188.5	24.0	1.04

Discussion

Results of the researches confirmed the data of other authors [19-28] about demand in determination of optimal parameters of sportsmen's special workability. As a result of the conducted researches it was found that work during ski racing competitions on rough tracks has variable character. The main source of energy supply is organism's aerobic potentials, the level of which reaches 92-95% of maximal values. Alongside with it passing of different by length and time of passing rises, flat parts and descends causes different intensification of aerobic metabolism. It was also found that during passing of rises significant role in energy supply of ski racers is played by anaerobic sources. Their volume reaches 80% of their maximal values.

Thus, correlation of metabolic processes conditions prevalence of adaptation changes of leading functional systems, which ensure special workability of elite female skiers. Functional potentials of sportswomen with high level of realization of aerobic and anaerobic reserves approach to proper values of functional fitness. That is why in preparation of elite female skiers it is necessary to pay attention to their training.

Conclusions

On the base of systemizing of sportswomen's special workability indicators we determined model characteristics of quantitative values of functional fitness during passing different difficulty rises. We determined values of contributions of aerobic and anaerobic energy supply mechanisms. During passing rises they are key element for achievement of high sport results in ski racings.

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Conflict of interests

The authors declare that there is no conflict of interests.

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