

INTERACTION PECULIARITIES OF AGE SOMATIC INDICES AND SPORT RESULTS OF SKI-RACERS, PARTICIPANTS OF OLYMPIC WINTER GAMES

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Abstract. The aim of the research – is to analyze interaction peculiarities of age somatic indices and sport result of ski-racers women and men. participants of Olympic Winter Games. Indices of age, height, body mass, Kettle index (g/cm), body mass index (kg/m²) of ski-racers women and men who participated in skiing competitions in XVIII Olympic Winter Games in Nagano and XIX Olympic Winter Games in Salt Lake City have been analyzed. Mean values (\bar{X}) of age, some somatic indices and standard indices divergence (\pm SD) of the most powerful skiing teams (National Teams), skiers – medal winners as well as skiers who won 1–10, 11–20, 21–30 places in separate distances are presented in the article. Age of skiers women (n=14) – medal winners in Nagano Olympic Winter Games was 28.40 \pm 4.0 years, height – 167.10 \pm 5.10 cm, body mass – 57.00 \pm 5.40 kg, Kettle index – 340.50 \pm 23.20 g/cm and indices of skiers women (n=19) – medal winners in Salt Lake City Olympic Winter Games were analogous: age – 28.42 \pm 4.81 years, height – 168.84 \pm 5.08 cm, body mass – 59.05 \pm 5.76 kg, Kettle index – 349.22 \pm 27.22 g/cm. Age of skiers men – medal winners of Nagano Olympic Winter Games (n=16) was 29.8 \pm 4.0 years, height – 181.60 \pm 5.70 cm, body mass – 75.30 \pm 6.50 kg, Kettle index – 414.23 \pm 25.00 g/cm and indices of skiers men (n=21) – medal winners in Salt Lake City Olympic Winter Games were analogous: age – 28.48 \pm 2.93 years, height – 180.71 \pm 5.3 cm, body mass – 73.71 \pm 6.13 kg, Kettle index – 407.41 \pm 24.11 g/cm. Research results allow stating that height and body mass of skiers' women and men may be different. Possibilities to achieve high results have both tall and shorter as well as light and heavier skiers. Though body mass of men skiers and especially of women should be not heavy comparing with their height. Age, somatic indices of ski-racers women and men, Olympic medal

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winners, may be estimated as modeling and they may be used to make models for training high mastery ski-racers. *(Biol.Sport 23:55-72, 2006)*

Key words: Ski-racers - Physical development - Somatic indices - Body mass - Body mass index

Introduction

Man's physical development is analyzed as the feature of health and physical fitness and as the index of sport orientation and selection to particular sports [8,9,23,25,30,31]. Among factors describing man's abilities in particular sports anthropometrical indices such as height, body mass, body mass component ratio [9,12,14,17,18,23] are assigned as well. A particular body construction is characteristic to each sport [12,23,25,30]. Height, body mass and body mass components of sportsmen of different sports have a specific link to sport mastery [1,9,14,18,23,25,29]. Results of high mastery sportsmen much determined by genetic determinants as well. and somatic characteristics are among them [4,30]. Physical development analyses are a constituent of complex analysis programs for high mastery skiers [1,3,4,7,13,14,20].

Rational modeling of long-term training process of high mastery ski-racers related with optimal age limit prevision for highest sport results achievement. There are often cases in skiing sport that ski-racers up to 35 years and even older achieve very high sports results [6,7].

Evaluation of physical capacity for work and function abilities indices of ski-racers is related with body mass and its components ratio [4,7,13,14,19,29]. It is important that ski-racers body mass indices would be adequate to their aerobic capacity indices [19,24,29]. In skiing race, work energetic expenditures of ski-racers depend on their body mass as well [19,20,21]. Maximal oxygen metabolism to one body mass kilogram (kg^{-1}) of lighter ski-racers is bigger than of heavier ski-racers [1,7]. In different skiing track distances ski-racers' sliding speed maybe influenced by ski friction, wind age, body weight, initial sliding speed [1,2,27].

Scientists' research [1,3,15,16,26,27] has not yet showed link between ski-racers body mass indices and sliding speed during world-class skiers competition. Body mass influence to sports achievements of elite skiers have been little analyzed yet. Age, somatic features and sport result interaction of elite ski-racers is a topical research problem.



The aim of the research – is to analyze age and somatic indices and its interaction peculiarities with sport result of ski-racers (women and men), participants of Olympic Winter Games.

The object of the research – age, somatic data and sport results of ski-racers medal winners, the most powerful world teams (National Teams) and skiers who won 1–10, 11–20, 21–30 places in skiing competitions.

Materials and Methods

Age, somatic features data and sport results of women (n=97) and men (n=113) that participated in ski-race competitions in XVIII Olympic Winter Games in Nagano (1998) and 105 women and 143 men of the same competition in XIX Olympic Winter Games in Salt Lake City (2002) have been analyzed.

The following research methods were used: analysis of literature sources, analysis of Olympic Games ski-race competition documents [5,28], mathematical statistics: arithmetic mean (\bar{X}), standard divergence ($\pm SD$), data difference importance index (p). Data of ski-racers' age, height and body mass have been found and used from Olympic Game documents. There has been calculated Kettle index (g/cm), body mass index (kg/m^2) [12,20]. Ski-racers' sport results have been estimated according to won places in separate competition distances and FIS (Federation of International Skiing) penalty points, scored for lag from the winner [5,28].

Results

Age averages (Table 1) of skier's women, participants of ski-race competition in Nagano Olympic Winter Games were 26.0 ± 4.2 years. Norwegian skiers women were the tallest – 170.5 ± 2.6 cm – among the most powerful women from Olympic Skiing Teams and the smallest and lightest were skiers from Japan – 160.03 ± 2.7 cm and 53.0 ± 1.8 kg respectively.

Age averages (Table 3) of skier's women from the most powerful National Olympic Teams (according to number of medals and won 4th–10th places) of Salt Lake City Olympic Winter Games were from 25.14 ± 2.27 years to 29.00 ± 6.14 years height averages fluctuated from 164.33 ± 3.54 cm to 173.00 ± 6.78 cm, body mass fluctuated from 54.78 ± 5.07 kg to 61.60 ± 2.61 kg and body mass index from 19.75 ± 0.45 kg/m^2 to 21.86 ± 0.94 kg/m^2 . Data of age and somatic indices of skier's men, participants of ski-race competition in Nagano and Salt Lake City Olympic Winter Games are presented in Tables 2 and 4. Age years average of skiers men,



participants of Nagano Olympic Winter Games was 26.9 ± 4.0 years, height – 178.6 ± 6.1 cm, body mass 72.3 ± 6.6 cm. The tallest were skiers from Germany – 184.5 ± 1.7 cm and Norway – 183.6 ± 7.3 cm and the smallest were Japanese skiers – 167.2 ± 1.9 cm (Table 2). In Salt Lake City Olympic Games among the most powerful National Olympic Teams of Skiing the tallest were skiers from Norway (184.60 ± 5.62 cm), Sweden (184.11 ± 4.08 cm), and Estonia (183.17 ± 4.34 cm). The smallest were Japanese Team skiers – 169.67 ± 3.93 cm (Table 4).

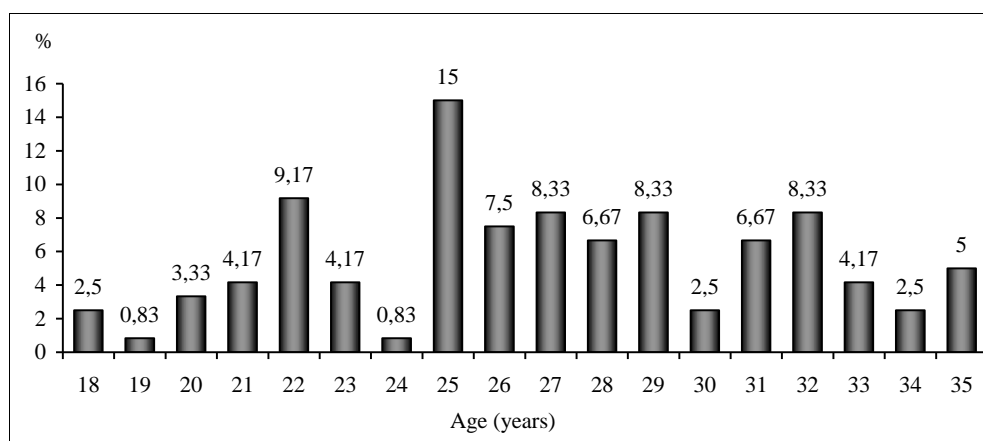
Table 1

Mean values ($\bar{x}\pm SD$) of age and somatic indices of racers women. participants of Nagano Olympic Winter Games and of National Olympic Skiing Teams

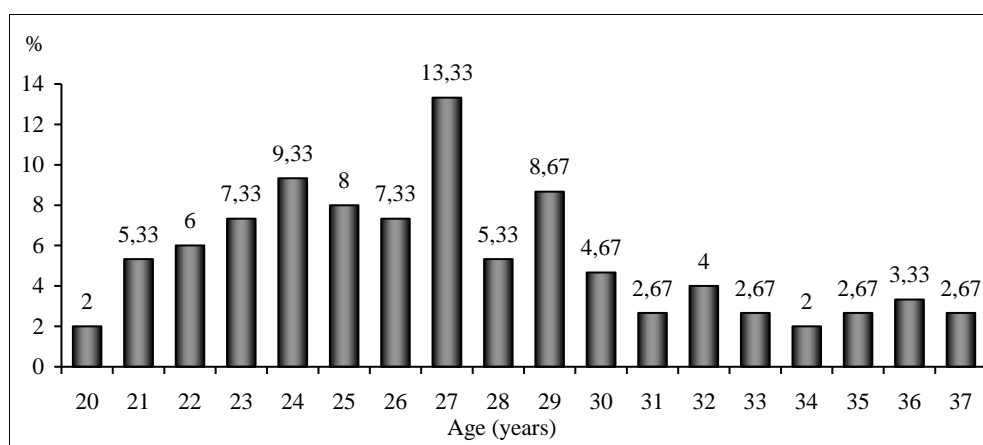
Groups of skiers- female	n	Age (years)	Body height (cm)	Body mass (kg)	Kettle index (g/cm)
Skiers-female	97	26.0 ± 4.2	166.9 ± 5.6	57.1 ± 4.4	341.91 ± 19.93
National team					
Russia	8	27.6 ± 4.6	165.6 ± 5.9	55.1 ± 3.9	332.54 ± 14.53
Norway	6	29.5 ± 2.9	170.5 ± 2.6	59.2 ± 3.1	346.92 ± 14.86
Italy	7	26.7 ± 4.5	165.7 ± 5.9	55.0 ± 5.5	331.47 ± 25.55
Finland	6	25.7 ± 4.3	165.2 ± 4.2	58.5 ± 2.2	354.30 ± 13.90
Sweden	5	30.0 ± 4.7	170.4 ± 3.1	61.4 ± 2.5	360.38 ± 11.17
Czech	4	23.0 ± 2.4	170.3 ± 4.5	61.8 ± 5.3	362.27 ± 21.83
Switzerland	5	24.8 ± 3.7	168.0 ± 7.0	55.6 ± 6.0	330.28 ± 22.51
Japan	6	25.0 ± 3.3	160.3 ± 2.7	53.0 ± 1.8	330.52 ± 8.8
Estonia	5	23.4 ± 4.2	169.0 ± 1.0	56.0 ± 5.1	332.60 ± 28.48
Byelorussia	5	26.6 ± 4.8	166.2 ± 4.6	56.0 ± 2.9	336.82 ± 10.51
Ukrain	4	26.3 ± 4.0	164.5 ± 3.1	53.5 ± 2.4	325.29 ± 14.82

Data of percentage distribution according to age of skiers' women and men who won 1–30 places in individual skiing competition are presented in Figs. 1-4. Skiers-women of 25 years were more qualified – 15% (Fig. 1) – to the first thirties in Nagano Olympic Winter Games and women of 27 years were more qualified – 13.33% (Fig. 2) to the first thirty of Salt Lake City Olympic Games. Skiers-men of 27 years were more qualified – 14.17% (Fig. 3), to the first thirty of ski-race competition in Nagano Olympic Winter Games and in Salt Lake City Olympic Games – skiers-men of 28 years and it made 13.33% (Fig. 4).



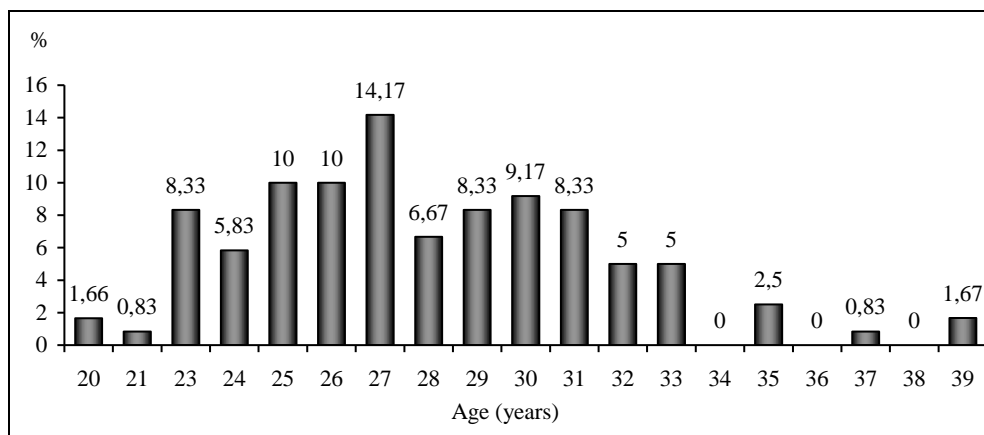
**Fig. 1**

Age distribution (%) of skiers' women, who won 1–30 places in individual ski-race in Nagano Olympic Winter Games

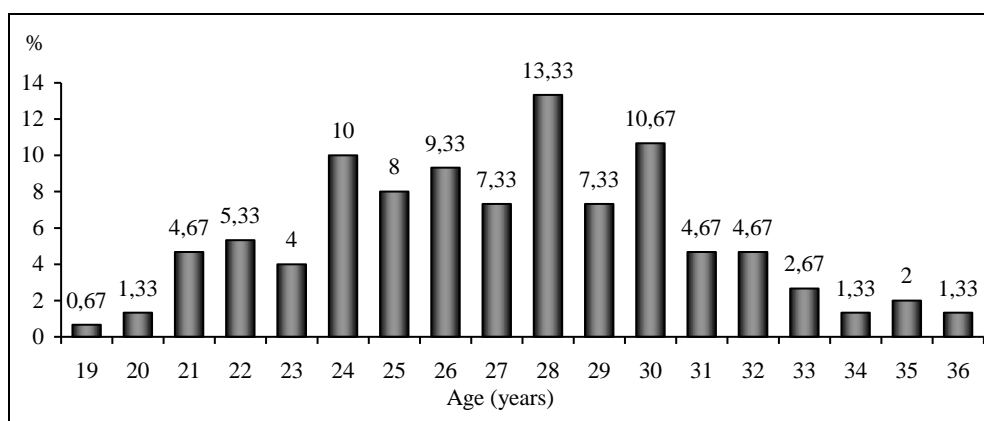
**Fig. 2**

Age distribution (%) of skiers' women, who won 1–30 places in individual ski-race in Salt Lake City Olympic Winter Games



**Fig. 3**

Age distribution (%) of skiers' men, who won 1–30 places in individual ski-race in Nagano Olympic Winter Games

**Fig. 4**

Age distribution (%) of skiers' men, who won 1–30 places in individual ski-race in Salt Lake City Olympic Winter Games



Table 2

Mean values ($\bar{x} \pm SD$) of age and somatic indices of ski-racers men participants of Nagano Olympic Winter Games and of National Olympic Skiing Teams

Groups of skiers-man	n	Age (years)	Body height (cm)	Body mass (kg)	Ketle index (g/cm)
Skiers-men	113	26.9±4.0	178.6±6.1	72.3±6.6	404.39±25.81
National team					
Norway	8	27.0±2.8	183.6±7.3	78.4±5.6	426.40±15.17
Italy	5	29.4±4.6	180.2±5.9	74.2±6.5	411.30±25.08
Finland	4	30.5±5.8	179.5±4.1	70.8±5.0	393.85±19.68
Sweden	7	27.3±4.7	180.9±5.0	75.6±5.1	421.04±20.79
Austria	6	29.0±4.3	181.0±6.4	74.2±6.6	409.18±24.89
Russia	8	27.1±3.5	177.6±4.9	70.5±6.0	396.45±25.06
Germany	4	29.5±5.3	184.5±1.7	79.3±4.9	429.52±25.50
Japan	5	25.2±2.3	167.2±1.9	61.6±1.8	368.44±10.68
Byelorussia	4	25.5±3.3	175.5±3.7	70.3±3.3	400.18±12.86
Estonia	5	26.8±2.4	178.2±8.2	72.8±7.9	407.75±28.80

14 skiers women and 16 skiers men won medals (there were contended for 5 sets of medals including skiing relay-race) in Nagano Olympic Winter Games [28]. 19 skiers women and 21 skiers men won medals in Salt Lake City Olympic Winter Games [5] where were contended for 6 sets of medals (including skiing relay-race). Mean values (\bar{X}) of age and somatic indices of skiers' women (Table 5) and men (Table 6) who won ski-race competitions in Nagano and Salt Lake City Olympic Winter Games differed little ($p > 0.05$). Skiers women-medal winners [6] of Nagano Olympic Games were distributed according to age as follows: 21–25 years – 28.57%, 27–30 years – 42.85%, and over 30 years – 28.57%. And skiers women-medal winners of ski-race competition in Salt Lake City Olympic Winter Games were distributed in the following order: 21 years – 10.53%; 22 years – 5.27%; 24–30 years – 47.37% and over 30 years – 36.84%. Skier's men-medal winners of ski-race competition in Nagano Olympic Games were distributed according to age [6] as follows: 23 years – 6.25%, 26–30 years – 62.50%, over 30 years – 37.50%. And skiers' men-medal winners of Salt Lake City Olympic Winter Games were distributed in the following order: 22 years – 4.76%, 24–25 years – 14.28%, 27–30 years – 57.14%, over 30 years 23.81%.

Table 3

Mean values ($\bar{x} \pm SD$) of age and somatic indices of ski-racers women, from the most powerful Olympic Teams, participated of Salt Lake City Olympic Winter Games

Countries	n	Won medal	Won places 4–10	Age (years)	Body height (cm)	Body mass (kg)	Kettle index (g/cm)	BMI (kg/m ²)
Russia	8	3	4	27.67 ±5.43	166.50 ±2.20	55.50 ±2.07	332.98 ±10.89	20.02 ±0.74
Norway	7	4	6	29.00 ±6.14	169.00 ±3.54	62.40 ±2.48	367.26 ±14.26	21.86 ±0.94
Italy	9	4	6	27.33 ±3.77	164.33 ±5.15	54.78 ±5.07	336.84 ±27.43	20.30 ±1.74
Germany	5	3	4	25.20 ±3.03	164.00 ±4.53	56.80 ±2.61	345.86 ±26.96	21.04 ±1.23
Canada	5	1	4	25.80 ±1.92	168.40 ±1.82	59.20 ±3.49	351.42 ±17.43	20.86 ±0.87
Czech	7	2	1	25.14 ±2.27	168.57 ±4.86	57.71 ±5.91	341.77 ±25.75	20.25 ±1.00
Switzerland	4	1	1	27.25 ±4.11	173.00 ±6.78	59.25 ±5.56	341.92 ±19.68	19.75 ±0.45
Finland	6	–	3	27.17 ±6.59	169.00 ±6.23	58.50 ±3.56	346.00 ±13.25	20.77 ±0.61

Skiers women-medal winners of ski-race competition in Nagano and Salt Lake City Olympic Winter Games had the following height: 167.10±5.10 cm and 168.84±5.08 cm ($p > 0.05$), body mass index – 20.36±0.97 kg/m² and 20.68±1.35 kg/m² ($p > 0.05$) respectively. Skiers' men-medal winners of ski-race competition in Nagano Olympic Winter Games were 181.60±5.70 cm of height, body mass index 22.80±1.00 kg/m², and same indices of skiers' men medal winners of ski-race competition in Salt Lake City were 180.71±5.30 cm and 22.49±1.00 kg/m² ($p > 0.05$) respectively. Age, height and body weight indices of skiers who won consequently 1–10, 11–20 and 21–30 places in different of skiing competitions is separately presented in Tables 7-10.



Table 4

Mean values ($\bar{x} \pm SD$) of age and somatic indices of ski-racers men. from the most powerful Olympic Teams. participated of Salt Lake City Olympic Winter Games

Countries	n	Won medal	Won places 4–10	Age (years)	Body height (cm)	Body mass (kg)	Ketle index (g/cm)	BMI (kg/m ²)
Norway	10	7	5	29.90 ±3.18	184.60 ±5.62	77.70 ±7.44	420.25 ±29.13	22.76 ±1.10
Estonia	6	3	2	29.33 ±3.04	183.17 ±4.34	76.67 ±4.50	415.63 ±12.38	22.71 ±0.50
Italy	10	2	5	27.9 ±3.51	178.8 ±5.09	72.60 ±4.43	405.86 ±17.89	22.58 ±1.07
Austria	6	2	2	28.50 ±3.99	180.50 ±8.18	75.00 ±7.83	414.61 ±28.83	22.91 ±1.25
Germany	6	2	2	26.00 ±4.05	179.50 ±5.55	72.67 ±5.28	405.64 ±19.37	22.67 ±0.81
Russia	9	1	6	25.67 ±5.24	177.89 ±5.35	70.56 ±3.54	396.75 ±19.33	22.34 ±1.39
Sweden	9	1	3	27.67 ±3.00	184.11 ±4.08	79.44 ±5.13	431.32 ±23.12	23.40 ±1.22
USA	8	–	1	27.38 ±5.37	179.38 ±5.63	73.69 ±4.27	410.25 ±14.27	22.86 ±0.84
Japan	6	–	1	27.33 ±2.73	169.67 ±3.93	65.00 ±4.73	376.63 ±23.76	22.21 ±0.96
Finland	8	–	1	28.25 ±3.96	179.13 ±4.05	73.00 ±6.44	407.61 ±31.50	22.78 ±1.69

In Nagano Winter Olympic Games age averages of women skiers who won 1–10 places in women skiing competitions of distances (5 km and 15 km in classical style, 30 km in free style) are only slightly larger than age averages of women skiers who won 11–20 and 21–30 places (Table 7).

Age averages (\bar{X}) of ski-racers women first tenth winners in combined style competitions (5 km classical style + 5 km free style), 15 km free style, 10 km and 30 km race in classical style fluctuated from 27.90±4.33 years to 30.40±4.93 years and little different ($p > 0.05$) from age averages of skiers women who won 11–20 and 21–30 places (Table 9). Averages of body mass index (kg/m²) of skiers women who won 1–10, 11–20, 21–30 places in sprint (1.5 km) race were little bit higher



($p > 0.05$) than of skiers who won same places in combined racers, 15 km race in free style and 30 km race in classical style (Table 9).

Table 5

Age and some somatic indices ($\bar{x} \pm SD$) of skiers' women, champions and prizewinners of ski-race competition in Nagano and Salt Lake City Olympic Winter Games

Olympic Winter Games	n	Age (years)	Body height (cm)	Body mass (kg)	Kettle Index (g/cm)	BMI (kg/m ²)
Nagano	14	28.40 ±4.00	167.10 ±5.10	57.00 ±5.40	340.50 ±23.20	20.36 ±0.97
Salt Lake City	19	28.42 ±4.81	168.84 ±5.08	59.05 ±5.76	349.22 ±27.22	20.68 ±1.35
Reliability of differences among indices	p	>0.05	>0.05	>0.05	>0.05	>0.05

Table 6

Age and some somatic indices ($\bar{x} \pm SD$) of skiers' men, champions and prizewinners of ski-race competition in Nagano and Salt Lake City Olympic Winter Games

Olympic Winter Games	n	Age (years)	Body height (cm)	Body mass (kg)	Kettle Index (g/cm)	BMI (kg/m ²)
Nagano	16	29.80 ±4.00	181.60 ±5.70	75.30 ±6.50	414.23 ±25.00	22.80 ±1.00
Salt Lake City	21	28.48 ±2.93	180.71 ±5.30	73.71 ±6.13	407.41 ±24.11	22.49 ±1.00
Reliability of differences among indices	p	>0.05	>0.05	>0.05	>0.05	>0.05



Table 7

Mean values ($\bar{x} \pm SD$) of age and somatic indices of ski-racers women who won 1–30 places in individual ski-race in Nagano Olympic Winter Games

Distance intervals	Won places	Age (years)	Body height (cm)	Body mass (kg)	Ketle index (g/cm)
15 km in classical style	1–10	28.6 ±3.7	169.5 ±7.4	57.9 ±6.0	340.98 ±24.70
	11–20	27.7 ±5.4	166.2 ±5.8	56.6 ±5.1	341.20 ±27.19
	21–30	24.9 ±2.2	166.4 ±2.8	55.4 ±4.5	334.95 ±28.99
	1–10	29.1 ±3.1	171.0 ±3.7	59.8 ±4.4	349.42 ±16.69
	11–20	26.2 ±5.3	165.0 ±7.2	53.4 ±4.6	324.32 ±24.80
	21–30	25.2 ±5.7	165.0 ±4.8	56.6 ±4.2	341.04 ±17.10
5 km in classical style	1–10	27.9 ±3.6	167.1 ±6.3	56.8 ±6.1	339.20 ±25.27
	11–20	28.2 ±5.4	170.6 ±5.3	57.6 ±5.4	347.10 ±39.65
	21–30	27.0 ±4.2	163.5 ±2.8	54.7 ±3.0	334.45 ±14.96
	1–10	29.0 ±3.4	166.2 ±5.9	55.6 ±5.0	334.03 ±20.00
	11–20	25.7 ±4.2	169.7 ±5.6	57.4 ±4.1	338.16 ±19.61
	21–30	28.6 ±3.7	169.5 ±7.4	57.9 ±6.0	340.98 ±24.70

Averages of body mass index (kg/m^2) of skiers' men who won 11–20 and 21–30 places in sprint race were little bit higher ($p > 0.05$) than of skiers who won same places in other skiing distances (Table 10).



Table 8

Mean values ($\bar{x} \pm \text{SD}$) of age and somatic indices of ski-racers men who won 1–30 places in individual ski-race in Nagano Olympic Winter Games

Distance intervals	Won places	Age (years)	Body height (cm)	Body mass (kg)	Kettle index (g/cm)
30 km in classical style	1–10	29.4 ±5.5	180.4 ±5.1	73.3 ±5.9	405.88 ±23.42
	11–20	28.7 ±2.9	181.8 ±6.1	75.8 ±6.8	416.31 ±25.70
	21–30	25.1 ±3.4	178.3 ±8.7	71.2 ±7.8	401.20 ±31.64
	1–10	29.0 ±2.7	183.0 ±5.8	76.3 ±6.6	416.35 ±25.17
	11–20	29.2 ±4.8	179.1 ±6.2	71.9 ±5.7	401.00 ±20.91
	21–30	27.7 ±2.8	179.6 ±6.6	74.1 ±6.7	411.89 ±24.20
10 km in classical style	1–10	29.4 ±2.0	181.1 ±4.8	75.1 ±5.6	414.38 ±23.56
	11–20	27.5 ±4.0	181.4 ±5.4	73.8 ±6.1	406.38 ±24.37
	21–30	26.4 ±3.2	173.7 ±7.7	68.2 ±7.1	391.81 ±24.80
	1–10	28.6 ±3.0	179.8 ±6.4	75.5 ±6.9	419.29 ±26.50
	11–20	26.8 ±4.2	182.2 ±6.2	75.9 ±7.0	416.04 ±26.83
	21–30	26.3 ±3.0	178.3 ±6.6	72.3 ±6.7	405.09 ±27.29
Combined race (10 km in classical style + 15 km in free style)	1–10	29.4 ±2.0	181.1 ±4.8	75.1 ±5.6	414.38 ±23.56
	11–20	27.5 ±4.0	181.4 ±5.4	73.8 ±6.1	406.38 ±24.37
	21–30	26.4 ±3.2	173.7 ±7.7	68.2 ±7.1	391.81 ±24.80
	1–10	28.6 ±3.0	179.8 ±6.4	75.5 ±6.9	419.29 ±26.50
	11–20	26.8 ±4.2	182.2 ±6.2	75.9 ±7.0	416.04 ±26.83
	21–30	26.3 ±3.0	178.3 ±6.6	72.3 ±6.7	405.09 ±27.29
50 km in free style	1–10	29.4 ±2.0	181.1 ±4.8	75.1 ±5.6	414.38 ±23.56
	11–20	27.5 ±4.0	181.4 ±5.4	73.8 ±6.1	406.38 ±24.37
	21–30	26.4 ±3.2	173.7 ±7.7	68.2 ±7.1	391.81 ±24.80
	1–10	28.6 ±3.0	179.8 ±6.4	75.5 ±6.9	419.29 ±26.50
	11–20	26.8 ±4.2	182.2 ±6.2	75.9 ±7.0	416.04 ±26.83
	21–30	26.3 ±3.0	178.3 ±6.6	72.3 ±6.7	405.09 ±27.29



Table 9

Mean values ($\bar{x} \pm \text{SD}$) of age and somatic indices of ski-racers women who won 1–30 places in individual ski-race in Salt Lake City Olympic Winter Games

Distance intervals	Won places	Age (year s)	Body height (cm)	Body weight (kg)	BMI (kg/m ²)	Ketle index (g/cm)	FIS points
Combined race (5 km in classical style + 5 km in free style)	1–10	29.20 ±4.66	169.90 ±4.31	57.92 ±11.28	20.89 ±1.05	355.01 ±23.69	9.39 ±4.34
	11–20	28.10 ±5.40	164.80 ±3.91	56.50 ±5.32	20.71 ±1.28	342.38 ±26.14	32.22 ±10.25
	21–30	26.10 ±2.92	168.60 ±5.82	59.50 ±6.49	20.90 ±1.71	353.00 ±32.05	45.28 ±3.12
10 km in classical style	1–10	30.40 ±4.93	167.90 ±4.61	58.10 ±6.14	20.56 ±1.34	345.42 ±29.01	12.48 ±7.96
	11–20	28.78 ±5.29	165.00 ±3.74	56.89 ±3.81	20.91 ±1.42	344.17 ±21.62	35.64 ±5.37
	21–30	25.30 ±2.75	166.20 ±6.56	59.60 ±5.68	21.54 ±1.15	358.83 ±24.14	45.24 ±5.53
15 km in free style	1–10	30.40 ±4.81	167.40 ±5.15	57.60 ±6.02	20.50 ±1.10	343.44 ±26.60	10.32 ±6.47
	11–20	27.40 ±4.50	164.50 ±3.34	54.30 ±3.74	20.04 ±1.30	329.46 ±21.29	41.82 ±14.53
	21–30	25.10 ±2.92	166.50 ±5.19	56.70 ±5.06	20.80 ±1.25	340.44 ±26.77	67.07 ±6.81
30 km in classical style	1–10	27.90 ±4.33	166.90 ±4.25	57.10 ±6.44	20.44 ±1.47	341.47 ±31.27	14.82 ±12.29
	11–20	27.00 ±5.73	168.30 ±6.06	57.60 ±5.66	20.37 ±2.01	336.39 ±44.58	39.74 ±5.05
	21–30	26.20 ±3.29	169.10 ±6.37	58.80 ±5.43	21.03 ±1.36	352.76 ±26.03	66.29 ±8.95
1.5 km sprint in free style	1–10	27.30 ±4.27	165.56 ±5.32	57.56 ±5.61	21.00 ±1.00	349.81 ±23.99	–
	11–20	29.30 ±5.10	167.70 ±3.40	60.30 ±3.68	21.07 ±0.79	355.36 ±16.09	–
	21–30	24.60 ±4.43	165.30 ±6.31	59.20 ±3.33	21.70 ±1.40	358.31 ±16.74	–



Table 10

Mean values ($\bar{x} \pm \text{SD}$) of age and somatic indices of ski-racers men who won 1–30 places in individual ski-race in Salt Lake City Olympic Winter Games

Distance intervals	Won places	Age (years)	Body height (cm)	Body mass (kg)	BMI (kg/m ²)	Kettle index (g/cm)	FIS points
Combined race (10 km in classical style + 10 km in free style)	1–10	28.00 ±2.36	183.40 ±4.62	76.10 ±6.24	22.59 ±1.08	414.51 ±25.86	7.305 ±3.27
	11–20	27.50 ±5.17	178.70 ±4.32	72.00 ±3.77	22.36 ±1.33	401.93 ±17.42	15.24 ±2.37
	21–30	29.20 ±4.59	177.10 ±6.21	71.60 ±6.67	22.82 ±1.08	403.67 ±26.18	22.05 ±2.57
15 km in classical style	1–10	28.20 ±4.02	182.40 ±4.50	74.50 ±6.19	22.36 ±1.13	408.02 ±26.24	17.11 ±8.50
	11–20	26.70 ±4.50	179.40 ±7.97	72.30 ±7.79	22.43 ±1.12	402.16 ±28.85	34.39 ±4.02
	21–30	26.20 ±4.08	179.30 ±6.90	73.20 ±5.45	22.78 ±1.32	408.07 ±22.02	41.70 ±1.74
30 km in free style	1–10	28.00 ±3.30	179.00 ±4.99	72.7 ±6.36	22.75 ±1.34	405.78 ±28.39	34.73 ±15.07
	11–20	28.30 ±4.03	179.90 ±5.55	73.00 ±6.83	22.31 ±1.22	405.12 ±45.80	62.45 ±5.28
	21–30	26.70 ±8.11	176.70 ±53.76	71.00 ±20.94	22.75 ±6.57	401.23 ±117.87	75.63 ±18.03
50 km in classical style	1–10	29.22 ±3.27	181.90 ±6.33	74.00 ±6.60	2.28 ±0.88	402.29 ±33.02	14.21 ±7.23
	11–20	28.10 ±6.19	180.40 ±5.04	74.00 ±5.62	22.71 ±0.70	409.75 ±20.89	38.33 ±3.83
	21–30	26.7 ±4.64	178.00 ±6.41	71.40 ±6.48	22.53 ±0.97	398.60 ±26.31	51.69 ±4.76
1.5 km sprint in free style	1–10	26.00 ±3.02	180.00 ±5.42	73.75 ±5.84	22.73 ±0.98	409.12 ±21.31	–
	11–20	23.80 ±9.33	180.89 ±7.06	75.44 ±7.83	23.01 ±1.21	416.35 ±29.95	–
	21–30	26.33 ±5.20	179.33 ±5.16	74.67 ±6.02	23.25 ±1.99	416.44 ±32.63	–



Discussion

Sportsmen of different sports are distinguished by specific physical development features. Part of physical development indices is genetically determined and other indices much depend on sport activity specificity, organism adaptation to particular physical loads [4,8,29,30]. Body type determines Sportsmen's sport results to a certain degree and in various sports a particular body soma-type of a sportsman dominates [12]. Important factors having influence to man's motory abilities are physique (height, weight, body proportions, non-muscular percentage of the body mass), organs morphology and structure, biochemical processes in organism, nervous and hormone control of organism processes [17].

Fröhner and Wagner [12] recommends to perform a selection of sportsmen to sports taking into account indices of body soma-types, body mass and body mass component ration. Selecting young skiers for training sessions in sports schools and programming training process it is necessary to take into account age, sex and typological peculiarities of skeleton muscle [4]. Timakova [29] has investigated that important criterion of skiers' selection for high sport result achievement is adequate match of aerobic capacity and strength indices to body mass. Kinematical characteristic features of ski-racers individual sliding ways techniques partly depend on height and body mass indices [1,15]. When skiers slide nose-to-tail in pursuit race or mass start competitions, wind age power is lower when sliding after taller skier than after the smaller one [2]. There have not been identified a reliable correlation link between skiers body mass indices and distance reach results [27]. Berg and Forsberg [1] have investigated, that elite skiers (men) of small and big physique are almost one the same level of sport result achievement. World Skiing Cup men competition winners and prizewinners are a little heavier than other skiers [1]. Heavier skiers according to sliding speed have advantage of flat track distances and slopes, but have no advantages of climbing up a mountain. World Skiing Cup winners women body mass do not differ from other skiers [1]. There is a negative correlation link between skiers women body mass and oxygen uptake (VO_2) beside anaerobic threshold limit [19]. High mastery Russian Skiing Team skiers-women ($n=11$) age was 27.5 ± 6.5 year, height – 165.00 ± 2.50 cm, body mass – 58.00 ± 3.50 kg, and Russian Youth Skiing Team skiers-women ($n=9$) age was 18.5 ± 1.5 years, height 167.00 ± 3.50 cm, body mass – 59.00 ± 2.50 kg [14]. Age limits of skiers-medal winners in skiing competitions of Olympic Winter Games change little: 1956s Olympic medal winners' women age was 26–30 year, men age was 27–29 years, in Olympic Games in 1992 (Albertville, France) and in 1994 (Lillehammer,



Norway) skiers women-medal winners age was 24–28 years, and men age was 25–30 years [10]. Further better results achievement of ski-racers in Olympic Winter Games is related with training process optimization evaluating individual motory abilities and optimal age limit prevision for highest sport results achievement [11,22].

Ski racers women of 21–35 years and men of 23–39 won medals of skiing race in Nagano Olympic Winter Games. Among ski racers women medal winners the youngest was of 21 and she was Olympic champion of 30 km race in free style. The youngest ski racer man medal winner was of 23 and two older ski racers – 37 and 39 years – won medals of relay-race 4x10km.

Ski racers women of 21–37 years and men of 22–34 won medals of skiing race in Salt Lake City Olympic Winter Games. Among ski racers women medal winners were light skiers (with little body mass), whose body mass index was 17.97 kg/m² – 19.46 kg/m², Kettle index – 287.05 g/cm – 321.43 g/cm and heavier skiers with bigger body mass, whose body mass index was 21.40 kg/m² – 22.69 kg/m² and Kettle index 369.94 g/cm – 380.95 g/cm.

Ski racers men medal winners in Salt Lake City Olympic Winter Games were light, and body mass index was 20.99 kg/m² – 21.30 kg/m², Kettle index 377.78 g/cm – 383.33 g/cm and there were heavier skiers as well, with bigger body mass, whose body mass index reached 23.26 kg/m² – 24.27 kg/m² and Kettle index – 436.17 g/cm – 442.10 g/cm. Ski racers men medal winners height was from 170 cm to 190 cm (among ski racers were men whose height was more than 180 cm).

Conclusion

Ski racers (women and men) with different height and different body mass indices achieve excellent results in skiing race. Ski racers body mass is not big when comparing it with a height.

Ski racers women under 21 and men under 22 are not able to win Olympic medals. To first tenth fall older ski racers than racers of the second and third tenths. Age and somatic indices of women and men Olympic medal winners may be estimated as modeling and that may be a base for planning many years training process of high mastery ski racers.

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