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A comparative analysis of men's team and individual large hill (K-125) ski jumping competitions at the 2014 Winter Olympic Games in Sochi

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Introduction. Ski jumping is a winter Olympic sport which made its debut at the 1924 Winter Olympics in Chamonix. At the same time the International Ski Federation (FIS) was established. The first large hill ski jumping competition was held during the 1964 Winter Olympics in Innsbruck, and the team ski jumping competition was inaugurated at the Winter Olympics in Calgary in 1988 [1]. Aim of Study. The study is a comparative analysis of team and individual large hill (K-125) ski jumping competitions at the 2014 Winter Olympic Games in Sochi. The analysis covered ski jumpers' distances, speed, age, nationality, and body build types. Material and Methods. The study sample consisted of all male ski jumpers taking part in the 2nd round of the Olympic competition (30 jumpers in the individual event, 24 in the team event). The ski jumpers' results, take-off speeds, age and the number of falls were compared using official FIS reports. Results. The characteristics of the individual and team ski-jumping competitions were determined. The ski jumpers' nationality and age were compared, and a correlation was found between the results and rankings in the competitions and ski jumpers' body build. Conclusions. High ranks in the ski-jumping team competition are not associated with the ranks in the individual competition. The teams usually featured a lower mean age, body surface and greater body mass and body height. The ski jumpers can be categorized as the leptosomic body type.

KEYWORDS: Winter Olympics, take-off speed, flight speed, ski jumping, ski training, Rohrer's index.

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What is already known on this topic?
Ski jumping research has hitherto focused mainly on biomechanical aspects, relationships between take-off speed and the final score, ski length and competitors' body mass.

Introduction

The paper is a comparative analysis of men's team and individual large hill (K-125) ski jumping competitions at the 2014 Winter Olympic Games in Sochi. Although the beginnings of Olympic ski jumping go back to the 1920s, there have been rather few scientific publications on this sport. Researchers so far have mostly focused on the biomechanical and motor aspects of ski jumping [2]. Studies were carried out during ski flying competitions or the Summer Grand Prix competitions. Some studies were concerned with the analysis of flight technique [3]. Research studies directly connected with Olympic ski jumping have predominantly concentrated on the history of the sport. The present paper aims to compare both men's Olympic ski jumping competitions on the basis of a few hypotheses: ski jumpers' nationality has a different effect on the result of the team competition than the individual competition; the mean age of top ski jumping teams is lower than of individual ski jumpers; a high rank in the team competition is not synonymous with a high result in the individual competition; the ski jumpers' body build has no decisive impact on the final result; and a higher take-off speed does not guarantee a high ranking place in the competition.

The following indices were calculated [4]:

- Rohrer's Index (RI) – a measure of leanness of a person; RI = {body mass (g) × 100} / body height (cm)^3;
- Quatelet's Index I (QII); WQI = body mass (g) / body height (cm);
- Body Mass Index (BMI) determining the degree of one's underweight or overweight; BMI = body mass (kg) / body height (m)^2.

Aim of Study

The study examined similarities and differences between ski jumping performances at two competitions: men's team and men's individual during the Olympic Games in Sochi in 2014. The main focus was the analysis of ski jumpers' take-off speed and their landing distances. Also parameters such as competitors' body build (body mass, body height, BMI, Quatelet's Index I, Rohrer's Index) as well as age and nationality were compared.

Material and Methods

The participants were ski jumpers who took part in the 2nd series of the Olympic ski-jumping competitions in Sochi on February 15, 2014 (men's individual large hill competition) and on February 17, 2014 (men's team large hill competition).

The comparative method was used to determine similarities and differences between two groups (ski jumpers in the men's individual and men's team competitions). The quantitative analysis was made on the basis of reports from the International Ski Federation. The nationality, age, somatic build and take-off speeds were compared between the two groups of ski jumpers. The correlation coefficient was calculated to examine correlations between the variables (Table 1).

Results

On the basis of collected data characteristic parameters of ski jumpers taking part in the men's individual and team ski jumping competitions were determined. It was revealed that a high take-off speed had a significant impact on the length of the landing distance. The competitors who achieved the maximal take-off speed were the members of the victorious team of the team event (Table 3, 4). The correlation coefficient was high in the 1st series of jumps ($r_1 = 0.57$), and medium in the 2nd series ($r_2 = 0.40$).

Table 1. Strength of correlations between examined variables

Correlation coefficient (r)	$r = 0$	$0 < r < 0.1$	$0.1 < r < 0.3$	$0.3 < r < 0.5$	$0.5 < r < 0.7$	$0.7 < r < 0.9$	$0.9 < r < 1$
Strength of correlation	no	very low	low	average	high	very high	full

Table 2. Mean index values of ski jumpers taking part in the 2nd series of the men's team competition

Rank	Age	Body mass	Body height	RI	QII	BMI	Mean rank (individual)
1	23.00	66.25	182.75	1.08	362.00	19.80	16.00
2	24.00	62.00	179.50	1.08	345.25	19.24	22.00
3	29.00	59.50	174.00	1.11	344.62	19.63	9.00
4	25.00	58.75	175.00	1.10	335.67	19.19	16.00
5	27.00	60.75	176.25	1.11	344.64	19.56	19.00
6	27.00	59.75	176.00	1.10	339.78	19.63	21.00
7	31.00	59.25	174.25	1.13	339.86	19.50	23.00
8	27.00	61.75	177.25	1.06	348.17	19.06	27.00

BMI – Body Mass Index, RI – Rohrer's Index, QII – Quatelet's Index I

Table 3. Mean index values of ski jumpers taking part in the 2nd series of the men's individual competition

Age	Body mass	Body height	RI	QII	BMI
27.00	61.63	176.67	1.04	347.53	19.61

BMI – Body Mass Index, RI – Rohrer's Index, QII – Quatelet's Index I

Table 4. Take-off speeds achieved by ski jumpers during the 2014 Olympic ski-jumping competitions in Sochi

Competition	Avg. (km/h) 1st series	Min.–Max (km/h) 1st series	Avg. (km/h) 2nd series	Min.–Max (km/h) 2nd series
men's individual large hill Sochi (15.02)	93.1	92.1–94.2	92.8	92.4–93.2
			93.0	92.6–93.6
			92.8	92.5–93.2
men's team large hill Sochi (17.02)	92.8	92.2–93.4	93.4	92.8–93.7
	93.0	92.6–93.4	93.2	92.7–93.6
	93.3	92.9–93.9	93.5	93.1–94.0
	92.8	92.1–93.3	93.3	92.7–93.9

Avg. – average speed

The number of junior ski jumpers participating in the Olympic ski-jumping competitions in Sochi was non-significant: only one junior ski jumper, 19-year-old Jarkko Maeaettae from Finland, took part in the event (43rd place in the men's individual competition, 8th in the men's team competition).

Table 5. Mean age of ski-jumping medalists at the 2014 Olympic Games in Sochi

competition	1st place	2nd place	3rd place	Mean age
men's individual large hill Sochi (15.02)	27	42	21	30
men's team large hill Sochi (17.02)	23	24	29	25

Statistically, the winners of the men's individual competition were older than the winners of the team competition. They also had mean lower body mass and body height and can be described as the leptosomic type (Rohrer's Index below the norm). The ski jumpers from the medal-winning teams were younger and had greater body mass and body height (Table 2). The gold medal team members had the greatest body height and body mass as well as the highest BMI. They were not, however, the winners of the individual competition, and their mean rank was 16th. In terms of the number of falls, only one fall took place during each competition (K-95, individual K-125, team K-125). As far the ski jumpers' nationality was concerned, only the Japanese and the Czech ski-jumping teams advanced to the 2nd series in 100%. 75% of national team members advanced to the 2nd series from the German, Polish, Slovak and Norwegian national teams.

Discussion

Ruchlewicz and Staszkiewicz [5] examined the relationship between the in-run speed and the jumping distance. They observed that changes in the in-run length by lowering or raising the start bar affected the take-off speed. Vaverka [6, 7] noted that the introduction of the V-style of ski jumping increased the ski jumper's lifting surface and – in consequence – the jumping distance. He found a positive correlation between the in-run speed and the jump length (from 0.35 to 0.56), and a contribution of the in-run speed to the total variance of jump length from 14 do 33%. He also observed a decreasing trend between the examined variables. Ruchlewicz [8] discussed the relationship between the ski jumper's body build the length of the skis. According to him, a ski jumper's greater lifting surface (greater body height) does not compensate for a greater body mass. That is why a potential solution to this problem for many ski jumpers was reduction of body mass. However, slimming became pointless after the FIS established the maximum ski length at 146% of the ski jumper's body height. Tsutomu Sasaki et al. [9] discussed the impact of kinematic indices of the flight on the landing distance in their study of ski jumpers taking part in the Summer Grand Prix in Hakuba in 1999. They noted that ski jumpers who did not change their positions during the flight, may increase their speed.

Conclusions

The examined ski jumpers had their BMI in the normal range (BMI > 18.50) and were classified, according to Rohrer's Index, as leptosomic type (RI < 1.13 for men) They had a lean body build, low body mass, dominant length parameters over width parameters, long neck and face, and narrow chest. They can be classified as the weak body build type, according to Quatelet's Index I (QII < 388.80) (Table 6).

Table 6. Somatic classifications of ski jumpers

Index	Below	Norm	Above
BMI	2	28	0
RI	19	11	0
QII	30	0	0

BMI – Body Mass Index, RI – Rohrer's Index, QII – Quatelet's Index I

The ski jumpers' age has no significant impact on the ski jumping results. This can be best illustrated by 42-year-old Noriaki Kasai from Japan, who won the silver medal during the large-hill competition (Table 5).

The standard body mass was compared to the body mass of ski jumpers using the Broca Index [men: body mass (kg) = body height (cm) – 100 × 0.9; women: body mass (kg) = body height (cm) – 100 × 0.85, for individuals with the body height between 160 and 190 cm], and the Broca-Brugsh Index [body height up to 164 cm: body mass = body height – 100; 165-175 cm: body mass = body height – 105; 176-190 cm: body mass = body height – 110]. The body mass of all the ski jumpers was below the index standard values.

The places won in the individual competition and the team competition were highly correlated (Pearson's r 0.65); however, it should be noted that 27 ski jumpers from the 2nd series of the individual competition took part in the team competition, including 24 ski jumpers in the 2nd series of the team competition.

What this paper adds?

The study focuses on the significance of body build of ski jumpers for their jumping distance. The characteristics of ski jumpers' body build are examined as well as correlations between places won by ski jumpers in the Olympic men's individual and men's team competitions.

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