Hindawi
Mobile Information Systems
Volume 2022, Article ID 8481138, 12 pages
https://doi.org/10.1155/2022/8481138

Research Article

Study on Technical Movements' Spatial and Temporal Characteristics of Women's Ski Jumping to Utilizing AI in 5G Network for Data Processing

Wan Nan and Lei Wei

Jiangxi Science and Technology Normal University, Nanchang 330038, China

Correspondence should be addressed to Wan Nan; 710497033@qq.com

Received 17 May 2022; Revised 18 June 2022; Accepted 12 July 2022; Published 8 October 2022

Academic Editor: M. Praveen Kumar Reddy

Use of literature, mathematical statistics, information technology, and other methods, analysis of Sochi 2014 Winter Olympics women's ski jumping in time and space projects feature of the technical movement, with the New vision of Remote E-health with 5G and Beyond is analyzed, in which the fifth generation of cellular wireless technology can explore healthcare with its high speed and massive connection vitality and accelerate the growth of diagnosis with great assistance by the Remote E-health which aims to further explore the world of technical movement elite women ski jumping characteristics. The results showed that (1) technical characteristics of the time, "slip stage, take-off preparation stage, parabolic trajectory cast peace movement" four stages the length of time is proportional to the ranking of the final scores. (2) the space characteristics of technical aspects, "slip stage" outstanding female athletes in the world to adopt to reduce air resistance with flat back slip posture; "Jump to feet slide" level with the least resistance lift larger bent type take-off position; "Parabolic trajectory falling phase athlete's ankle Angle, Angle of the knee and hip Angle 180°; "Horizontal cast trajectory" athletes "voids and ankle Angle" degree is reduced, along with the increase of the degree of hip Angle two skis front distance increases, straight knee joint degree are 180°, such a can obtain maximum lift-to-drag ratio, make further flight distance. Studies suggest that coaches in the selection, training, and participation in periodic arrangement of large games can refer to the theoretical parameters of this study and make the appropriate decisions.

1. Introduction

Ski jumping, which originated in Norway, is a performance project in which human beings challenge the limit and show the posture of taxiing and stagnating in the air [1]. As the project is very adventurous and challenging, women's ski jumping was not carried out in the Winter Olympic Games [2]. After nearly 90 years, it was listed as an official event in the 2014 Sochi Winter Olympics. Based on this, it is necessary to explore and analyze the spatial and temporal characteristics of the competitive skills of the top eight female ski jumpers who entered the Olympic Games for the first time [3, 4]. The purpose is to reveal the technical parameters of the elite female ski jumpers, to provide theoretical reference for the coaches and athletes engaged in the women's ski jumping events in China [5]. For ski jumping, we generated a new 2D posture dataset that can be used for further research that connects computer vision and sports sciences [6]. Even though there are numerous large-scale human pose datasets, the vast majority of them do not include many photos of skiers and do not have the skis and poles labeled [7]. This void is filled by downloading 16 ski jumping films from Youtube under the Creative Commons license, which included mostly semiprofessional athletes from many different views and in varied weather situations and a variety of different angles [8]. As part of the dataset, hand-annotated pictures from 1982 of amateur to semiprofessional alpine ski racers have been included [9]. It is decided to mark occluded joints by making the best estimate at their real location. Each participant is represented by a unique identifier in the dataset. Individuals may choose from five different places, each with a different type of weather (from sunny to foggy) [10]. Slalom and Giant Slalom are filmed 32 times each, while Super-G is filmed 26 times, while Downhill is shot 24 times. There are also six training sequences filmed with a follow-cam from near to far away [11]. The ski jumping controls in the progress of the extreme by resulting in the simulation for performance and which make the mind-blowing for the drag values in the body movements for MI formulas for considering the sitting height for the flight stability. The take-off ramp will make the understanding of the equipment for the ease landing of the ski jumping [12]. The landslide will manage the massive loss for the geological perspective for the technical evaluation in the ski jumping for the critical evaluation for the ground condition. The dynamic excavation will manage the numerical calculations for the slope frequency and will manage the characteristics in the energy for the high frequency to produce the peak particle velocity (PV). The single index will make the stress for the rocky slopes to manage the multiple indices [13].

2. Research Object and Method

2.1. Research Object. This paper takes the top 8 women platform jumping athletes in the 2014 Sochi Winter Olympic Games as the research object.

2.2. Research Method

2.2.1. Documentation Method. Through the Internet search in China National Knowledge Infrastructure (CNKI), Wanfang database, and other platforms, a total of 237 relevant documents were obtained, among which 24 references were of reference value to the author; at the same time, the author consulted two books on ski jumping through the interlibrary loan function, which provided reference and support for the smooth progress of this study. China National Knowledge Infrastructure (CNKI) a full-text database of Chinese academic journals, China Academic Publications Full-Text Library is the world's largest and most frequently updated database of Chinese journals [14].

2.2.2. Information Technology Law

(1) Data acquisition: download the 2014 Sochi Winter Olympics women ski jumping video (the resolution of the video is 1920×1080, which ensures the accuracy of the research), and the video data have two forms of constant speed playback and slow playback; [15].

(2) Video processing: use Sony high-speed camera to remake the HD (High dimensional) video data of the official website for the second time, and the frame number of remakes is set to 120 fps. This ensures the accuracy and objectivity of the research data. Finally, the super game V8 is used to slow down the remake HD game video, and the data are processed, and then the keyframes are inserted into the Dartfish motion technology analysis software for analysis, such as angle, height, distance, and so on [16].

(3) Picture making: input the processed data into EXCEL 2007 platform to make a visual diagram.

2.2.3. Mathematical Statistics. The effective data and videos collected on the Internet were processed by SPSS15.0 for windows and EXCEL 2007 Software on the computer, including descriptive statistical analysis, data regression modeling, and chi-square test.

2.3. Logical Analysis. A chi-square test is a statistical analysis used to compare observed and predicted outcomes in a given situation. To evaluate if a discrepancy between actual and predicted data is due to chance or a connection between the variables that are examined, this test is used [17]. Regression in sports is just a method of reducing the demand for a certain movement and activity. A development, on the other hand, achieves the exact opposite by gradually increasing the demand through small changes [18]. As a statistical model, regression analysis is used to identify the significant elements that influence the outcome of an event. Multivariate linear regression is typically used in sports betting. The results showed that passing efficiency has been the most significant factor in winning the sport [19]. Based on the collected and processed data, this paper uses the analysis method of sports biomechanics to deeply discuss the actual situation and problems and then puts forward some suggestions [20]. An in-depth analysis of sporting movements is used in biomechanics to reduce injury risk and increase performance. As a result, sports biomechanics is the study of how and why the human body movements the way it does to improve sports performance [21, 22].

2.4. Comparative Analysis Method. This paper compares the skills of the top 8 women platform skiing athletes in the 2014 Sochi Winter Olympic Games, to reveal the technical characteristics of women ski jumping in the world and explore its development trend.

As shown in Figure 1, (1) related angle indicators are as follows: α is the angle between the ankle angle and the tibia and the skateboard; β is the knee angle—the angle between the thigh and the calf; γ is the hip angle—the angle between the trunk and the thighs; and θ is the angle between the skis and the water level. (2) Related height indicators are as follows: according to the standard platform parameters stipulated by the International Snow Federation, the length of the slide is $L = 81$ meters, and the slope of the slide is between 35° and 37°. The official data of the competition show that the slope of the slide is 37° and the starting point slope is 12°. H represents the vertical distance between the highest point and the horizontal take-off point from the take-off point when the athlete performs "parabolic motion"; S is the final flight distance of the athlete. (3) The relevant index to the velocity and acceleration is as follows: V represents the instantaneous speed (officially measured by high-tech instruments) of the athlete gliding to the fifth point, that is, the speed at which the athlete takes off in

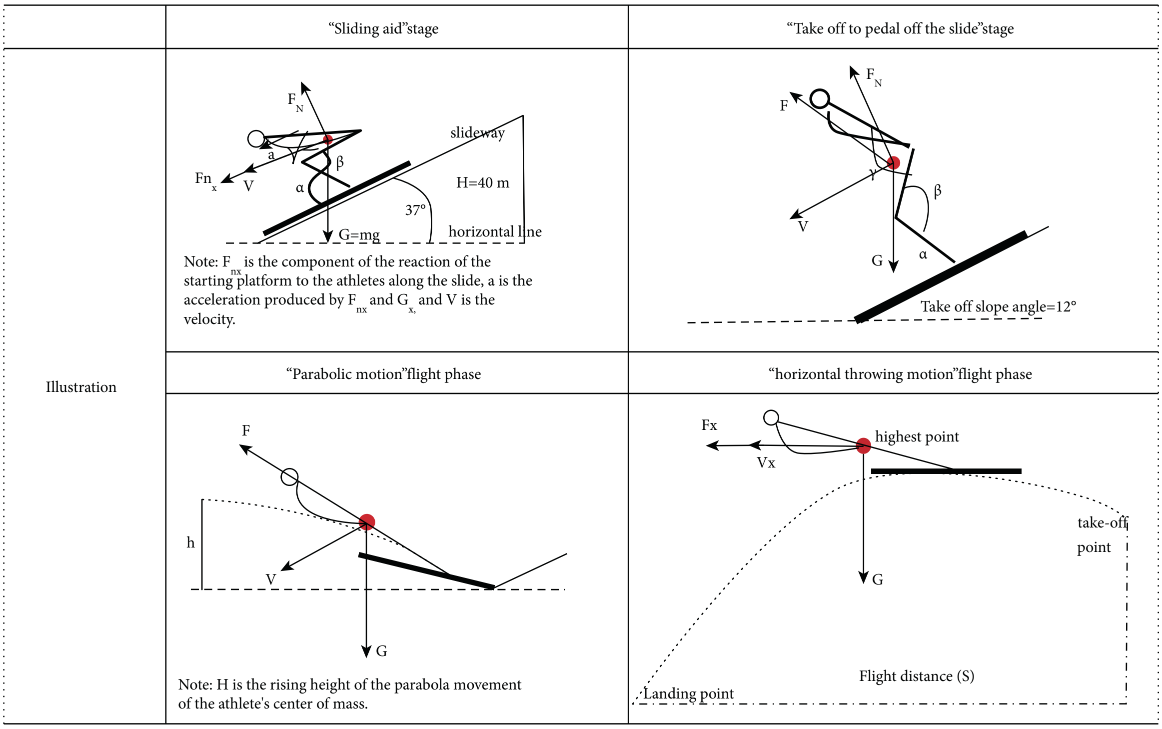

Figure 1: Women ski jumping project speed, force, air flight trajectory, and other information in the four stages.

a parabolic motion, which can be divided into horizontal speed V_x and vertical speed V_y based on physical and mechanical knowledge. The horizontal speed V_x pulls the athlete to fly far forward, while the vertical speed V_y pulls the athlete to move upward.stands for acceleration, whose value is equal to the sum of the partial acceleration of the athlete's gravity and the acceleration generated when the athlete quickly gets out of the static state by retreating from the starting platform with his upper arm, i.e., $a = g_x + a_{\text{push}}$. (4) Relevant stress index is as follows: in the "sliding aid" stage, the athlete is supported by the force F_N facing him on the slide, his gravity G, and thrust F_{push}. "Pushing off the slide" stage: the athlete is subjected to his/her gravity G and the support force of the slide is F_N facing him/her. When his/her feet push vertically down the slide, the reaction force F given to the athlete by the slide is upward along the shin. The flight phase of "parabolic motion": the athlete is subjected to the reaction force F and the gravity G exerted by the athlete on the slide. The flight stage of "flat throw motion": the athlete is subject to his/her own gravity G. The phrase "parabolic movement" is coined by traders. An upward price movement that looks like the right side of the parabolic curve is known as a parabolic movement. Parabolic movements occur when the stock's price increases at an exponentially increasing rate.

3. Results and Analysis

3.1. Spatial and Temporal Characteristics of the World's Elite Female Ski Jumpers in the "Assisting Skiing" Stage

3.1.1. Analysis of the Time Characteristics of the "Assist Sliding" Stage. According to sports biomechanics, it can be seen that in the stage from the "starting platform to the jumping point," the athlete is not only affected by the gravity G and the support force F_N of the slide to the human body but also the athlete uses both hands to push the "starting platform" to quickly get out of the static state. When the reaction force Freaction force of the platform to the athlete is inverse, and its calculation can be obtained by the mathematical trigonometric function and Newton's second law by mathematics trigonometric functions available formula is: $F_{Nx} = ma - G_x = * (2S/t_1^2) - G * \text{SIN37}$ (Note: S is the athlete's assist distance, $S = 40\,\text{m}/\sin 37$; when the gradient of the assist track is 37° and air resistance and friction are negligible, the relationship between Freaction force and ranking is discussed). The combined force of these three promotes the athlete to obtain the speed (V) and acceleration (a) to slide rapidly along the pavement, so the time (t_1) of each athlete from "slipping from the starting platform to the take-off point" is different, and the time for sliding down (t_1) = The total number of frames (Z_1) from the starting platform to the starting point × the time of each frame (T), the resolution of which is processed by a high-speed camera, and the number of frames reaches 120 fps, which ensures the accuracy and objectivity of the research data. The various parameters are shown in Figure 2. According to the above relationship, formulas, and data, Table 1 can be obtained.

Athletes from the "starting platform to the take-off point" are the initial stage of the whole ski jump. The performance of the athletes in this stage will directly affect the technical level of the flight stage, that is to say, the technical parameters in the initial stage play a crucial role in the final performance of the athletes. These technical parameters are seen from the results of Table 1: in terms of the characteristics of assist time, the world's elite athletes' assist time is about 5.37 m/s, and the speed of time is directly proportional to the ranking of

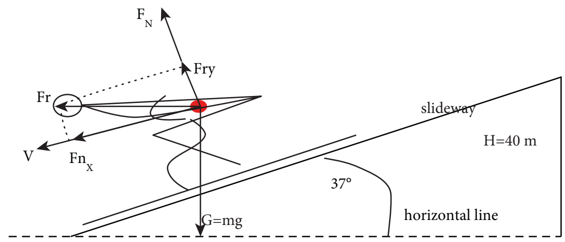

FIGURE 2: Force analysis diagram of athletes pushing their hands away from the starting platform.

TABLE 1: List of assist time and parameters for athletes to slide down rapidly along the pavement.

Rank	Athletes	Slide assist time (s)	G (N)	G_X (N)	F_{rX} (N)	$F = G_X + F_{rX}$
1	Carina VOGT(GRE)	5.265	607.60	364.56	38.03	402.59
2	Daniela IRASCHKO-STOLZ (AUT)	5.265	558.60	335.16	34.97	370.13
3	Coline MATTEL (FRA)	5.340	558.60	335.16	24.64	359.80
4	Sara TAKANASHI (JPN)	5.360	480.20	288.12	18.88	307.00
5	Evelyn INSAM (ITA)	5.430	597.80	358.68	13.71	372.39
6	Maja VTIC (SLO)	5.450	539.00	323.40	9.91	333.31
7	Yuki ITO (JPN)	5.450	470.40	282.24	8.64	290.88
8	Maren LUNDBY (NOR)	5.470	523.32	313.99	7.26	321.25
	Best parameter model: Range ($M \pm$ SD)	5.379 ± 0.084	541.94 ± 49.67	325.16 ± 29.80	19.51 ± 11.97	344.67 ± 37.78
	P	>0.05	>0.05	>0.05	<0.05	>0.05

Note: G_X is the component force of gravity along the slide direction; F_{nx} is the component force of the starting platform to the athletes along the sliding direction; F is the resultant force to prompt the athletes to slide down the pavement rapidly; g the acceleration of gravity is $9.8\,m/s^2$. This full athleticism is comprised of crucial components that work together to achieve physical fitness that is well-balanced and well-rounded. Athletes need to be able to perform at a high level of physical and mental persistence to succeed.

competition results. On the one hand, the greater the athlete's weight, the greater the acceleration along the slide produced by G_X, and the greater the acceleration, the greater the speed. On the other hand, when the athletes use their hands to push away from the starting platform and get rid of the static state, the greater the downward force along with the slide (F_{nx}). The greater the resultant force F_{nx}, the greater the acceleration along the slideway generated by F_{nx}, and the greater the acceleration. Based on this, German player Carina VOGT won the championship of the event, and compared with the parameters in Table 2, it is not difficult to find that with the lower-ranked athletes' reaction component, F_{nx} gradually decreases, that is, the F_{nx} reaction is also gradually decreasing. It can be seen that the performance of athletes has a direct relationship with the size of the reaction produced by pushing the "platform" with both hands when the athletes start the platform, which will certainly affect the resultant force that causes the athletes to slide down rapidly along the pavement, and the size of the resultant force restricts the acceleration and speed.

To sum up, the ranking of the world's top female ski jumpers is closely related to the speed produced by the gravity (G) and thrust reaction force F reaction force of the athletes. To decrease resistance and noise, sliding stage devices are primarily used for the linear movement of sliding tracks, such as the slide line of the machine. As a linear movement surface for devices, the stage can be utilized to properly receive devices because of its large sweep. A device that improves high-precision movement and reduces run out. On a more basic level, this stage is used for restricting an object only to one axis of movement.

3.1.2. Analysis of Spatial Characteristics in the Stage of "Assisting Sliding". According to Table 1, α is the angle between the tibia and the skateboard, β is the angle between the knee angle and the thigh, and γ is the angle between the hip angle and the trunk and the thigh. Based on this, the author has measured $\angle\alpha$, $\angle\beta$, and $\angle\gamma$ of the top 8 athletes and analyzed their sliding posture (the pictures are from the super clear track video, so the accuracy is high and can objectively reflect question). The obtained data are input into Excel 2007 for mapping, and Table 2 and Figure 3 are obtained.

According to Table 2, (1) in the aspect of "ankle angle, knee angle, and hip angle" of the world's elite female ski jumpers, the average values of ankle angle, knee angle, and hip angle in the "assistance stage" are 55.4°, 71.5°, and 31.2°, respectively. The single-sample t-test (Test Value is the mean value of each angle) showed no significant difference ($P > 0.05$), and the trend lines in Figure 3 are stable. These signs fully show that the world's elite female ski jumpers in the "assisting stage" of the space competition indicators tend to be similar. This represents the technical characteristics and models of the world's elite female ski jumpers in the "assisting stage," that is, when the range of "ankle angle, knee angle, and hip angle" is $55.4° \pm 4.0°$, $71.5° \pm 3.2°$, and $31.2° \pm 1.8°$, respectively, the better the athletes will get. The reasons are as follows: (1) the degree of ankle angle and knee angle should not be too small or too large. If the degree is too small, it is not conducive for the athletes to obtain the maximum speed required by the conversion of gravitational potential energy into kinetic energy. A substance's vibrating molecules gain potential energy when heated at a constant

Table 2: List of parameters of "ankle angle, knee angle, and hip angle" in the stage of assisting skating.

Rank	Athletes	Slide assist ankle angle	Slide assist knee angle	Slide assist hip angle	Slide assist posture
1	Carina VOGT (GRE)	61.1°	72.9°	31.6°	Flat back
2	Daniela IRASCHKO-STOLZ (AUT)	49.6°	65.2°	28.4°	Flat back
3	Coline MATTEL (FRA)	60.1°	73.9°	31.7°	Flat back
4	Sara TAKANASHI (JPN)	55.1°	74.8°	31.5°	Flat back
5	Evelyn INSAM (ITA)	54.9°	72.0°	32.8°	Flat back
6	Maja VTIC (SLO)	52.4°	69.9°	30.8°	Flat back
7	Yuki ITO (JPN)	57.7°	74.1°	29.1°	Flat back
8	Maren LUNDBY (NOR)	52.5°	69.5°	33.9°	Egg posture
	Best parameter model: Range ($M \pm$ SD)	55.4° ± 4.0°	71.5° ± 3.2°	31.2° ± 1.8°	Flat back
	P	>0.05	>0.05	>0.05	——

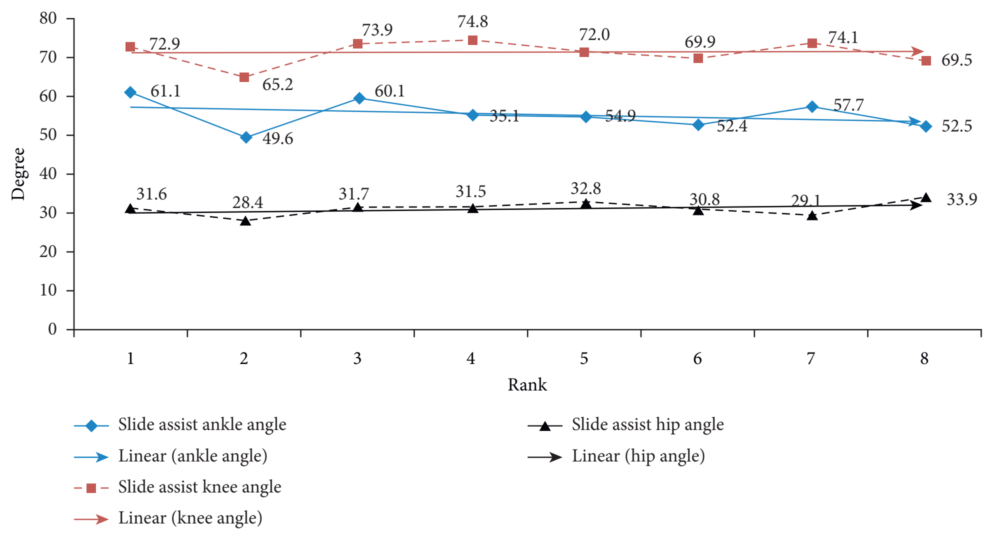

Figure 3: Analysis of the parameters of "ankle angle, knee angle, and hip angle" in the stage of assisting skating.

temperature, i.e., during its phase transition state, so they can overcome the intermolecular force of attraction and move around freely. As soon as they strike a ball with their bat and tennis racket, their task is complete. When a runner accelerates and gains kinetic energy, they are working. Once the kinetic energy is attained, more work must be done to overcome friction and keep the vehicle moving forwards. It is the food they eat that gives them their energy.

If the degree is too large, it is not conducive to the optimal displacement of the lower limbs. The results of these two aspects are that the best height h (shown in Table 1) can be obtained by influencing the lower limbs to "pedal off the slide," that is, the higher the H is, the higher the starting point of horizontal throwing is, and the higher the starting point is, the farther the flight distance is. (2) According to the principle of sports biomechanics, the ratio of ankle angle to knee angle must be less than 1, while the ratio of ankle angle, knee angle, and hip angle is about 2. Such a ratio is of great significance in lowering the center of gravity and maintaining balance. Its significance is to make the trunk close to the thigh and close to the slide. This kind of "slide assist" technology is conducive to reducing air resistance and improving the stability of the slide, so it is more conducive to the convergence of take-off technology and creates a good technical environment for the take-off force to pedal off the slide. Automatic activation devices (AADs): as the skydiver falls at a freefall speed, the AAD "fires" and releases the backup parachute when the skydiver reaches an altitude where it is dangerous to continue falling. (2) In terms of the characteristics of "athletes' posture" in the stage of assisting skating, according to the "Experimental Research on the initial flying posture of ski jumping in the air" published by Wang Zhixuan in "Sports Science" in 1998, the experiments of three kinds of assistant skiing postures in wind tunnel experiment are as follows: egg type, flat back type, and front supporting leg type, and the resistance is as follows: front supporting leg type > egg-type > flat back type. The advantage of the forward supporting leg style is that it is beneficial to take-off, but the increase of resistance will lose the speed of assisting sliding. The advantage of egg-type is that it can slide smoothly, but the lift drag ratio is the smallest. The advantage of the flat back type is that it has a large lift drag ratio and is conducive to the connection of "sliding and taking off" [1]. It can be seen that the flat back has the least resistance and the largest lift, so it is an ideal sliding-aid posture. Based on the above results, the author analyzes the top 8 female ski jumpers in this winter Olympic Games. The results are shown in Table 3. Among the top 8 athletes, 7 of them adopted the "flat back" position, ranking from the first to the seventh, while the eighth player adopted the egg style.

Table 3: Time table of starting lower limb exertion to the take-off point.

Rank	Athletes	Take-off preparation time (s)
1	Carina VOGT (GRE)	0.316
2	Daniela IRASCHKO-STOLZ (AUT)	0.311
3	Coline MATTEL (FRA)	0.310
4	Sara TAKANASHI (JPN)	0.322
5	Evelyn INSAM (ITA)	0.327
6	Maja VTIC (SLO)	0.230
7	Yuki ITO (JPN)	0.272
8	Maren LUNDBY (NOR)	0.271
	Best parameter model: Range ($M \pm$ SD)	0.297 ± 0.037
	P	>0.05

This shows that the "flat back" position is widely used by the world's elite female ski jumpers in the stage of helping the ski, which is conducive to the athletes to obtain good results in this event (Algorithm 1).

3.2. Spatial and Temporal Characteristics of the World's Elite Female Ski Jumpers in the "Take-Off Preparation Stage"

3.2.1. Analysis of the Time Characteristics of "Take-Off Preparation Stage". According to the rules of ski jumping, the "take-off" stage refers to the stage in which the athlete changes from a stable helping posture to the starting point of the lower limbs, that is, the stage when the athlete is about to step off the slide after the 6 m take-off area to the take-off point. The accuracy of grasping the time ($t_{\text{preparation}}$) in this stage will directly restrict the strength of athletes at the take-off point, thus affecting the height h of similar parabola movement in the next stage. According to statistics, the time of the "preparation stage" is shown in Table 3.

It can be seen from Table 3 that the average time of buffer take-off of the world's elite female ski jumpers is about 0.3 s, and there is no significant difference by single-sample t-test ($P > 0.05$). This shows that the world's elite female ski jumpers have a good grasp of the opportunity from high-speed help to take-off preparation stage, but it cannot be ignored that if the time of preparing for take-off is relatively sufficient, they will be more likely to achieve better results and rankings.

To sum up, the best time parameter of the world-class athletes from the start of lower limb strength to the take-off point is 0.297 ± 0.037.

3.2.2. Analysis of the Spatial Characteristics of "Take-Off Preparation Stage". According to Table 1, the spatial parameters of this stage also include $\angle\alpha$, $\angle\beta$, and $\angle\gamma$ and the athletes' take-off posture. Based on this, the author processed and counted the keyframes (120 fps) of continuous capture of super clear track video, and the results are shown in Table 4 and Figure 4.

Ankle-and-knee angles increased, and the body's center of mass (CoM) shifted rearward on the bend inrun path. For the analysis of the kinematic data acquired from the ankle and knee as well as from the trunk and center of mass (CoM), Pascal software has been used. When it comes to positioning, recent years have seen ski jumpers' ankle-and-knee joint angles decrease, while their trunk angles increased. Additionally, the hip joint moved concerning the ankle. Compared to ski jumpers, ski jumpers' ankle-and-knee joint angles are smaller, while their trunk angle is higher.

According to Table 4, (1) the average ankle angle, knee angle, and hip angle of the world's elite female ski jumpers in the "take-off stage" are 61.5°, 127.3°, and 104.9°, respectively. The single-sample t-test (Test Value is the mean value of each angle) showed no significant difference ($P > 0.05$), and the trend line of each angle in Figure 4 is stable. These signs fully show that the world's elite female ski jumpers in the "take-off preparation stage" of the space competition indicators tend to be similar. It symbolizes the technical characteristics and models of the world's elite female ski jumpers in the "take-off stage," that is, the range of "ankle angle, knee angle, and hip angle" is $61.5 \pm 4.8°$, $127.3° \pm 6.4°$, and $104.9 \pm 2.5°$, respectively, which is more conducive to the athletes to achieve better results. Through further analysis, we can find the rule that the "knee angle" and "hip angle" of athletes are about two times the ankle angle. Based on the relevant literature analysis, the reason lies in the fact that when taking off, the athletes pedal and stretch along the ankle angle tibia direction, the degree of ankle angle is not different from that of sliding, but the knee angle and hip angle are constantly increasing. The function of this method is to enable the athletes to get forward body posture and to prepare for the feet to push down the slide surface and quickly leave the slide track. This is why the knee angle and hip angle are about twice the ankle angle. It can be seen that in theory, when the knee angle and hip angle are two times the ankle angle, the better the athletes can obtain the better forward kinetic energy and the better the competition results and ranking will be. (2) In terms of the characteristics of "athletes' posture" in the jumping stage, according to Wang Xiwen and other scholars' research results on two kinds of take-off postures, namely, straight take-off and bent down take-off, published in "ice and snow sports" by Wang Xiwen and other scholars in 1993. The advantages of "straight body" take-off are good pedaling force, but large elevation angle (55° to 60°) and high resistance, which is not conducive to the increase of flight distance. The advantage of "bent body" take-off is that the lift drag ratio is small, which is conducive to the increase of flight distance, but it is difficult to grasp. [2] Therefore, it is an ideal take-off position because of its

(1) input; d1-ankle angle, d2-knee angle, d3-knee angle, SC-slide control
(2) initialize; slide-S
(3) evaluate the initial state of the slide
(4) if ($S = n$)
(5) start sliding
(6) else go to step 3
(7) if (network connectivity = 1 εS)
(8) start SC
(9) else repeat step 4
(10) while (SC&&d1 = 1) continue till target height is reached
(11) switch on d1
(12) record d1
(13) if ($d1 \leq 55.4^\circ \pm 4.0^\circ$)
(14) record value
(15) else repeat 11–14
(16) end if
(17) switch on d2
(18) record value of d2
(19) if ($d2 \leq 71.5^\circ \pm 3.2^\circ$)
(20) record value
(21) else repeat after an hour
(22) switch on d3
(23) record value of d3
(24) if ($d2 \leq 31.2^\circ \pm 1.8^\circ$)
(25) record value
(26) else repeat steps 21–23
(27) send record value to experts
(28) if (d1&&d2 = too high)
(29) not conducive optimal displacement of the lower limbs
(30) else if (d1&&d2 = too small)
(31) not conducive
(32) else
(33) flatback obtain good results in this event

Algorithm 1: Assisting stage-based smart health care system.

Table 4: "Ankle angle, knee angle, and hip angle" parameters of athletes from take-off to kicking off.

Rank	Athletes	Take off			Elevation angle	Posture
		Ankle angle	Knee angle	Hip angle		
1	Carina VOGT (Greece -GRE)	54.8°	126.3°	91.8°	19.4°	Bending
2	Daniela IRASCHKO-STOLZ (Austria -AUT)	56.9°	125.2°	98.8°	22.3°	Bending
3	Coline MATTEL (France-FRA)	59.1°	119.0°	84.5°	23.2°	Bending
4	Sara TAKANASHI (Japan-JPN)	63.6°	133.1°	102.4°	24.5°	Bending
5	Evelyn INSAM (Italy-ITA)	58.5°	123.1°	92.9°	24.6°	Bending
6	Maja VTIC (Slovenia-SLO)	64.8°	128.6°	87.3°	24.4°	Bending
7	Yuki ITO (Japan-JPN)	66.9°	123.7°	85.5°	25.6°	Bending
8	Maren LUNDBY (Norway-NOR)	67.3°	139.5°	96.0°	29.8°	Bending
	Best parameter model: Range ($M \pm$ SD)	$61.5^\circ \pm 4.8^\circ$	$127.3^\circ \pm 6.4^\circ$	$104.9^\circ \pm 2.5^\circ$	$24.6^\circ \pm 3.0^\circ$	—
	P	>0.05	>0.05	>0.05	>0.05	—

minimum resistance and large lift. Based on the above theory, the author analyzes the top 8 female ski jumpers in this winter Olympic Games. During the take-off of the top 8 athletes, the range of body elevation (elevation angle is the angle between the trunk and horizontal plane) is 19.4° to 29.8° and the average degree is 24.6° which is in line with the elevation parameter of bending take-off. There was no significant difference ($P > 0.05$). Note: the world's elite female ski jumpers generally adopt the take-off posture of the minimum resistance and large lift, which is worthy of our coaches' attention. Further analysis shows that although the elevation angle has no significant difference, the smaller its value, the better ranking. This is because the smaller the elevation angle formed between the trunk and the horizontal direction, the more favorable it is for the lower limbs to lift backward and reduce the elevation angle in the shortest time.

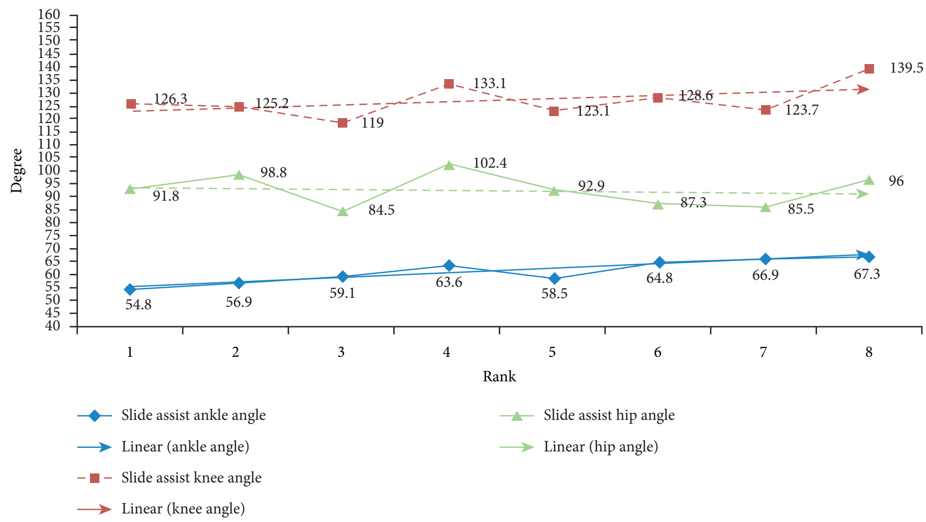

Figure 4: Analysis of the parameters of "ankle angle, knee angle, and hip angle" in the take-off stage of athletes.

And the formation of the whole body and forward direction of the same small elevation angle flight posture is conducive to reducing resistance and increasing flight distance. It can be seen that the smaller the elevation angle is, the better the performance will be. When a "random-access memory" skydive is opened, a slider is a small rectangular fabric piece with grommets at each corner. The term "reefing device" is used. It is common for a random-access memory parachute to open up extremely quickly. The slider glides down from the canopy to the risers during deployment. Rules that regulate the effective execution of abilities are called mechanical principles in sports. To improve sports performance, these mechanical concepts should be used in conjunction with other sports training methods based on Newton's Laws of Motion.

3.3. Spatial and Temporal Characteristics of "Parabola Trajectory" Stage of World Elite Female Ski Jumpers

3.3.1. Analysis of Time Characteristics of "Parabola Trajectory" Stage. According to the principles of sports biomechanics, after sliding down the slide, the ski jumper immediately makes a "parabolic trajectory motion" due to inertial action. When the athlete's center of gravity rises to the highest point, they begin the flat toss until they hit the ground. It can be seen whether the time when the athlete's center of gravity rises to make a parabolic trajectory affects the flight distance to a certain extent? Therefore, the author analyzes and calculates the high-definition video data (120 fps) processed by the high-speed camera and discusses its temporal characteristics. The results are shown in Table 5. For unbounded Kepler orbits with eccentricity equal to 1, parabolic trajectories lie exactly on the boundary of ellipse and hyperbola in celestial dynamics and celestial mechanics. Due to gravity, only the vertical component of the projectile's velocity will fluctuate along its course, but the horizontal component will remain the same.

It can be seen from Table 5 that the time range of the world's elite female ski jumpers moving off the slide in a parabola trajectory is 0.085 ± 0.019 s, and the average time is about 0.09 s. And by single-sample t-test, the world's top 8 players have significant differences ($P < 0.05$). This shows that there are differences in the ability of the world's elite female ski jumpers in this stage, and combined with the relationship between the ranking and time, the athletes with the top ranking in the results have a long time to rise in their centroid. Because the length of time directly reflects the level of the starting point of the next stage of horizontal throwing. Generally speaking, if the starting point of the horizontal throwing is high, the more conducive it is to increase the horizontal flight distance of the athletes, and the better they can create excellent results.

It can be seen that when the world's top athletes do "parabola movement" when pedaling off the slide, the athletes with a long time parameter of mass center rising are better at taking off with thigh spring force, to make the direction upward, have strength and height, to obtain higher parabolic flight track, and be ready for the next stage of flight.

3.3.2. Analysis of Spatial Characteristics in the Stage of "Parabola Trajectory". Does the spatial characteristic parameters of "parabola trajectory movement," including ankle angle, knee angle, hip angle, and height of centroid rise, affect the final performance ranking of athletes to a certain extent? To analyze its time characteristics, the author gives the Table 6.

According to Table 6, the ankle angle of the world's elite female ski jumpers in the "parabolic trajectory stage" is constantly decreasing, the knee angle is 180°, and the hip angle is close to 180° but the height of centroid rise is not the same. The better the athlete's performance ranking is, the higher the centroid rise will be, and the better the starting position will be for the next stage of high-altitude horizontal throwing flight. When the center of mass is high, the free-falling time in the vertical direction will be correspondingly extended, thus increasing the flight distance. It can be seen that if athletes want to achieve a more satisfactory result ranking, they should not only adjust the ankle angle, knee angle, and hip angle but also obtain a higher height of

Table 5: Time table of parabolic trajectory movement from "take off to pedal off the slide."

Rank	Athletes	The time when the center of mass rises to the highest point (s)
1	Carina VOGT (GRE)	0.116
2	Daniela IRASCHKO-STOLZ (AUT)	0.104
3	Coline MATTEL (FRA)	0.091
4	Sara TAKANASHI (JPN)	0.075
5	Evelyn INSAM (ITA)	0.094
6	Maja VTIC (SLO)	0.071
7	Yuki ITO (JPN)	0.066
8	Maren LUNDBY (NOR)	0.065
	Best parameter model: Range ($M \pm SD$)	0.085 ± 0.019
	P	<0.05

Table 6: List of parameters of "ankle angle, knee angle, and hip angle" in parabola trajectory stage.

Rank	Athletes	Ankle angle	Knee angle	Hip angle	The rising height of the center of mass (h)
1	Carina VOGT (GRE)	↓	180°	177.6°	0.31 m
2	Daniela IRASCHKO-STOLZ (AUT)	↓	180°	173.2°	0.28 m
3	Coline MATTEL (FRA)	↓	180°	172.5°	0.24 m
4	Sara TAKANASHI (JPN)	↓	180°	174.3°	0.20 m
5	Evelyn INSAM (ITA)	↓	180°	171.2°	0.25 m
6	Maja VTIC (SLO)	↓	180°	173.5°	0.19 m
7	Yuki ITO (JPN)	↓	180°	172.1°	0.17 m
8	Maren LUNDBY (NOR)	↓	180°	173.6°	0.17 m
	Best parameter model: Range ($M \pm SD$)	Gradually decrease	180°	$173.5° \pm 1.9°$	$0.23\ m \pm 0.05\ m$
	P	——	>0.05	>0.05	<0.05

centroid rise. It can be said that the height of the athlete's centroid plays a key role in this stage. And the height parameter (H) of centroid rise of different athletes has a significant difference ($P < 0.05$). The results show that the higher the height of the parabola rising movement, the better the performance ranking. There is a positive proportion between the two.

3.4. *Spatial and Temporal Characteristics of "Horizontal Throwing" Stage of World Elite Female Ski Jumpers*

3.4.1. Analysis of Time Characteristics of "Horizontal Throwing Trajectory" Stage. Kinematics is the study of the geometry of movement, which includes displacement, velocity, and acceleration of moving objects. Kinetics, on the other hand, studies the forces that create movement (gravity, friction, and so on), whereas kinematic describes the movement itself (velocity, acceleration, and so on). According to the kinematics track of ski jump, we can know that before landing, athletes do flat throwing. What are the characteristics of athletes' time in flat throwing? Does it affect the flight distance? For this reason, the author analyzes and calculates it and discusses its time characteristics. The results are shown in Table 7.

It can be seen from Table 8 that the time range of the world's top female ski jumpers from flat throwing to landing is $3.044\ s \pm 0.229\ s$, and the average time is about 3 s. And by single-sample t-test, the world's top 8 players have no significant difference ($P > 0.05$). This shows that the world's top female ski jumpers have better flight time in the last stage of flat throwing. However, further combined with the time of each athlete, it is not difficult to find that with the athletes' performance ranking behind the row, their time is constantly shortened. This further verifies that the "high center of mass" mentioned above is the key to obtaining the best flight distance. The reason lies in the following: when athletes are flat throwers, they are only affected by gravity. In the case of ignoring air resistance, the higher the starting point of the horizontal throwing movement is, the longer the free-falling movement time in the vertical direction will be. In other words, the longer the flight time is, the longer the distance will be correspondingly increased, and it will be easier to create excellent results.

For example, the shortest distance between two endpoints can be used to calculate horizontal flight performance (HFE), which is relatively straightforward. Planes that return to the sea are known as landing; however, they are also known as "touchdown" or "land safely." A typical aircraft flight can include taxiing, take-off, climbing, cruising, descending, and landing, among other things.

It can be seen that when world-class athletes do "flat throwing," the height of the center of mass determines the length of follow-up flight time, which also determines the length of flight distance.

3.4.2. Analysis of Spatial Characteristics in the Stage of "Horizontal Throwing Trajectory". The spatial characteristic parameters of "horizontal throwing trajectory" of athletes mainly include ankle angle, knee angle, hip angle, outside board angle, as well as V-shaped angle parameters of V-shaped flight technology (the so-called V-shape technology is that when flying, the width between the tail of the double board is less than the width of double board tip, and its shape looks like V in 26 English letters when looking up,

Table 7: A list of time parameter characteristics of "horizontal throwing motion to landing."

Rank	Athletes	Time (s)
1	Carina VOGT (GRE)	3.384
2	Daniela IRASCHKO-STOLZ (AUT)	3.259
3	Coline MATTEL (FRA)	3.195
4	Sara TAKANASHI (JPN)	3.127
5	Evelyn INSAM (ITA)	2.959
6	Maja VTIC (SLO)	2.829
7	Yuki ITO (JPN)	2.824
8	Maren LUNDBY (NOR)	2.775
	Best parameter model: Range ($M \pm$ SD)	3.044 ± 0.229
	P	>0.05

Table 8: List of spatial parameter characteristics of "horizontal throwing motion flight stage."

Rank	Athletes	Plate angle	Ankle angle	Knee angle	Hip angle	V-angle (angle between two plates)
1	Carina VOGT (GRE)	4.5°	25.6°	180°	170.7°	49.9°
2	Daniela IRASCHKO-STOLZ (AUT)	5.3°	26.6°	180°	166.8°	47.1°
3	Coline MATTEL (FRA)	5.6°	26.9°	180°	156.6°	48.3°
4	Sara TAKANASHI (JPN)	5.8°	27.6°	180°	158.2°	43.0°
5	Evelyn INSAM (ITA)	6.3°	38.2°	180°	157.0°	42.2°
6	Maja VTIC (SLO)	6.5°	41.3°	180°	149.5°	48.0°
7	Yuki ITO (JPN)	7.2°	42.2°	180°	148°	42.6°
8	Maren LUNDBY (NOR)	8.4°	43.3°	180°	149.5°	41.2°
	Best parameter model: Range ($M \pm$ SD)	$6.2° \pm 1.2°$	$33.9° \pm 7.9°$	180°	$173.5° \pm 1.9°$	$0.23\ \text{m} \pm 0.05\ \text{m}$
	P	<0.05	<0.05	—	<0.05	>0.05

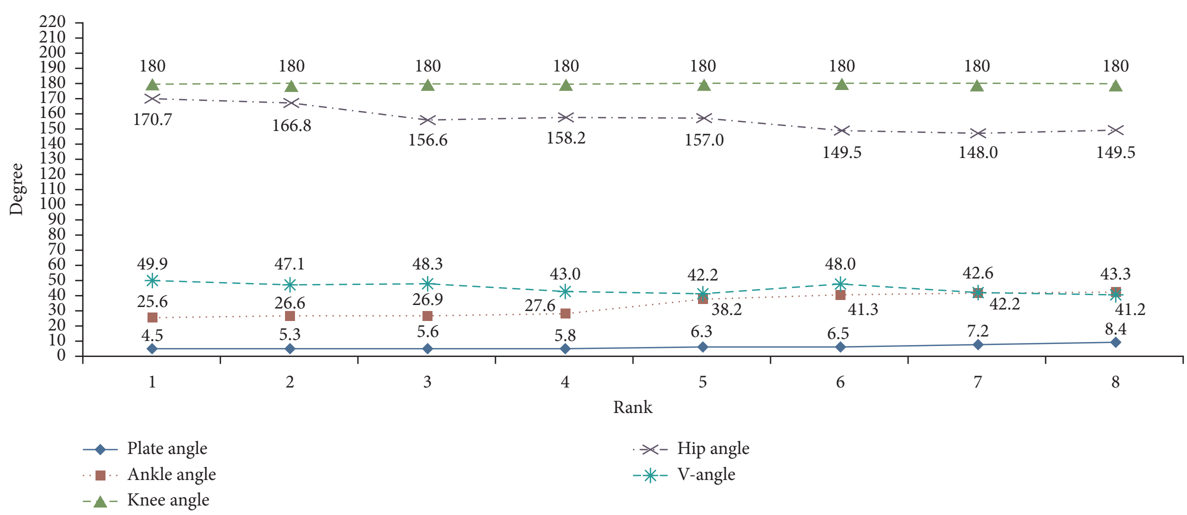

Figure 5: Line chart of spatial parameter characteristics of "horizontal throwing motion to landing."

so it is called V-shaped flight technology). Do these factors affect the final performance ranking of athletes to a certain extent? To explore this problem, the author calculated and analyzed the parameters of the space, and the results are shown in Table 8.

From Table 8 and Figure 5, it can be seen that (1) the angle of the board and ankle increases with the decrease of the ranking, while the "hip angle and V-shaped angle" decrease gradually. The difference was significant ($P < 0.05$). Explanation: the smaller the board angle and ankle angle, the larger the hip angle and V-angle, the better the performance of athletes. The reasons are as follows: first, the smaller the angle of the board (that is, the angle between the snowboard and the horizontal plane) is, the smaller the angle between the point on the horizontal throwing flight track and the landing slope is, and the higher the stagnation point of flight is, the better the gliding effect is and the farther the distance flight is. Secondly, the smaller the ankle angle is, the less the head-on resistance increased; thirdly, the larger the hip angle is, the closer the trunk and lower limbs are to a plane, so the area of lifting force is increased to the maximum extent, so the lifting force is increased to the greatest extent. Fourth, the larger the V-shaped angle, the greater the distance between the front ends of the two skis. According to the research of scholar Liu Shuming in the paper "optimization of flight posture and technology of ski jumping" [3], the larger the V-shaped angle is, the larger the area required to enhance the strength is, the larger the lift drag ratio is, and the longer the flight distance can be obtained. Ski jumping performance is affected not only by the athlete's motor function but also by the aerodynamic properties of the equipment used and by low body weight.

To sum up, athletes should reduce the degree of "board angle and ankle angle" as far as possible, increase the degree of "hip angle," at the same time, expand the distance between the front ends of two skis to the greatest extent, and fully extend the straight knee joint on the skis, to obtain the maximum lift drag ratio and make the flight distance longer.

4. Conclusion and Suggestion

4.1. Conclusion

4.1.1. The Space-Time Characteristics of the "Assistant Sliding" Stage

(1) In terms of time characteristics, the assisting time of the world's elite athletes is about 5.37 m/s, and the ranking of the results is positively proportional to the speed and time produced by the gravity (G) of the athletes themselves and the reaction force F of both hands pushing the starting platform.

(2) In terms of spatial characteristics, the competition indexes of the world's elite female ski jumpers tend to be similar, and the "flat back" posture is generally adopted. The models of "ankle angle, knee angle, and hip angle" are $55.4^\circ \pm 4.0^\circ$, $71.5^\circ \pm 3.2^\circ$, and $31.2^\circ \pm 1.8^\circ$, respectively. The parameters of these parameters are conducive to the athletes to obtain good results.

4.1.2. The Temporal and Spatial Characteristics of the "Take-Off Preparation" Stage

(1) In terms of time characteristics, the world's elite female ski jumpers will be more likely to achieve better results and rankings if they have enough time in the preparation stage of take-off, and the optimal time parameter is 0.297 ± 0.037.

(2) In terms of spatial characteristics, the world's elite female ski jumpers adopt the highest lift-to-drag ratio of the bending take-off posture, and its parameter model is knee angle, hip angle is twice of ankle angle degree, so the athletes can get better competition results and ranking.

4.1.3. Spatial-Temporal Features of "Parabola Trajectory" Stage

(1) In terms of time characteristics, the results of the world's elite female ski jumpers are in direct proportion to the time when their centroid rises.

(2) In terms of spatial characteristics, the higher the height of the parabolic ascent, the better the performance ranking. There is a positive proportion between the two.

4.1.4. The Space-Time Characteristics of the "Horizontal Throwing Trajectory" Stage

(1) In terms of time characteristics, the height of the mass center determines the length of follow-up flight time, which also determines the length of flight distance.

(2) In terms of spatial characteristics, the smaller the degree of "plate angle and ankle angle" and the greater the degree of "hip angle and V-angle" and the extension of the knee joint, the more lift drag ratio can be increased, to obtain the maximum lifting force and make the flight distance longer.

4.2. Suggestion. This paper makes an in-depth exploration and research on the overall situation of the top 8 world-class female ski jumpers who are listed as the official events of the Olympic Games for the first time, including the relationship between body shape, age characteristics and competition performance, and the relationship between technical parameters and competition results. Combined with the previous research results of scholars, some theoretical parameters are obtained around the existing problems of key technical links. These theoretical parameters can provide a certain reference value for the selection of coaches and the guidance of athletes' training. Based on this, it is suggested that our coaches and athletes refer to the relevant technical parameters of this study and put them into practice guidance, to better improve the competitive level of our athletes [17]. At the same time, this paper does not deeply study the applicability of 5G to personalized sports health management services and cannot make targeted and long-term analysis and suggestions for ski jumpers, which will be the focus of our next research.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

References

[1] Z. Wang, R. Li, and Z. Guan, "Experimental study on the initial flying posture of ski jump," *China Sports Science*, no. 02, pp. 55–58, 1998.

[2] X. Wang, D. Zhang, and W. Yuan, "A brief discussion on the technology of ski jump and take-off," *China Winter Sports*, no. 01, pp. 42–45, 1993.

[3] S. Liu, "Optimization of flight posture and technique in ski jump," *Journal of Shenyang Institute of Physical Education*, no. 02, pp. 22–24, 2002.

[4] C. Park, Z. Zhang, and H. Shihua, "A brief discussion on the take-off technique and aerial flight in ski jump," *Ice snow sports*, no. 09, pp. 13–15, 2004.
[5] C. Long, "Technical analysis of ski jump," *Journal of Shenyang Institute of Physical Education*, no. 01, pp. 20–23, 1992.
[6] C. Long and X. Wang, "Technical analysis of ski jump," *China Winter Sports*, no. 01, pp. 48–51, 1994.
[7] Y. Dong, W. Di, and Y. Lin, "Experimental study on the influence of take-off and flight attitude on flight distance," *China Winter Sports*, no. 03, pp. 21–23, 1995.
[8] O. M. Borzeninov, "The factors influencing the ski jump performance and the evolution of flying skills," *China Winter Sports*, no. 01, pp. 35–37, 1997.
[9] C. Long, "Analysis of V-shaped ski jumping technique," *Journal of Shenyang Institute of Physical Education*, no. 04, pp. 13–15, 1994.
[10] X. Park, J. song, and X. Pu, "Theoretical analysis of ski jump technology and the influence of athletes' body shape on ski jump performance," *China Winter Sports*, no. 03, pp. 27–29, 2000.
[11] S. Liu, M. Wei, and H. Liu, "Analysis of the characteristics and laws of ski jumping," *Journal of Shenyang Institute of Physical Education*, no. 02, pp. 13-14, 2003.
[12] S. Çelik, M. Özyazıcıoğlu, R. Şahin, H. Uysal, F. Z. Çakıcı, and E. Kalkan, "The destruction of Erzurum ski-jumping complex by a landslide: evaluation of an engineering design failure," *Natural Hazards*, vol. 107, no. 1, pp. 475–496, 2021.
[13] S. Zhang, W. Gao, M. Ye et al., "Dynamic response characteristics of a rock slope under blasting excavation," *Bulletin of Engineering Geology and the Environment*, vol. 80, no. 11, pp. 8453–8464, 2021.
[14] G. Zhang, J. Song, and X. Pu, "Analysis on the factors of evaluating the results of ski jumping competitions and the competitive ability of excellent skiers," *China Winter Sports*, no. 03, pp. 29-30, 2003.
[15] Z. Chen, "CFD Study on aerial flight stage of ski jump," *Zhejiang Sports Science*, no. 02, pp. 121–124, 2014.
[16] Y. Wang and B. Liu, "The dynamic influence mechanism of the structure of ski jump chute on the stance of ski jump," *Journal of Changchun Normal University (NATURAL SCIENCE EDITION)*, no. 02, pp. 121–126 + 131, 2014.
[17] L. F. Alves, D. Brandao, and M. A. Oliveira, "A multi-process pilot plant as a didactical tool for the teaching of industrial processes control in electrical engineering course," *International Journal of Electrical Engineering Education*, vol. 56, no. 1, pp. 62–91, 2019.
[18] https://www.epfl.ch/labs/cvlab/data/ski-2dpose-dataset/.
[19] M. Alazab and R. Broadhurst, "The role of spam in cybercrime: data from the Australian cybercrime pilot observatory," in *Cybercrime Risks and Responses*, pp. 103–120, Palgrave Macmillan, Londo, United Kingdom, 2015.
[20] G. Manogaran, P. M. Shakeel, H. Fouad et al., "Wearable IoT smart-log patch: an edge computing-based bayesian deep learning network System for multi access physical monitoring System," *Sensors*, vol. 19, no. 13, p. 3030, 2019.
[21] F. M. Choudhury, Z. Bao, J. S. Culpepper, and T. Sellis, "Monitoring the top-m rank aggregation of spatial objects in streaming queries," in *Proceedings of the 2017 IEEE 33rd International Conference on Data Engineering (ICDE)*, pp. 585–596, IEEE, CA, USA, April, 2017.
[22] G. Manogaran and D. Lopez, "Spatial cumulative sum algorithm with big data analytics for climate change detection," *Computers & Electrical Engineering*, vol. 65, pp. 207–221, 2018.
[23] R. Ghasemlounia and S. M. Saghebian, "Uncertainty assessment of kernel-based approaches on scours depth modeling downstream of ski-jump bucket spillways," *Water Supply*, 2021.
[24] V. Chavhan and G. Hinge, "Trajectory features and energy dissipation of conventional and modified (Deflector) Ski-Jump bucket," *Materials Today Proceedings*, vol. 49, pp. 1973–1979, 2022.
[25] S. Vega Piña, "Antenna Beam Steering and Beamforming at mm-Wave and THz Frequencies," Master's Thesis, Universitat Politècnica de Catalunya, Barcelona, Spain, 2021.